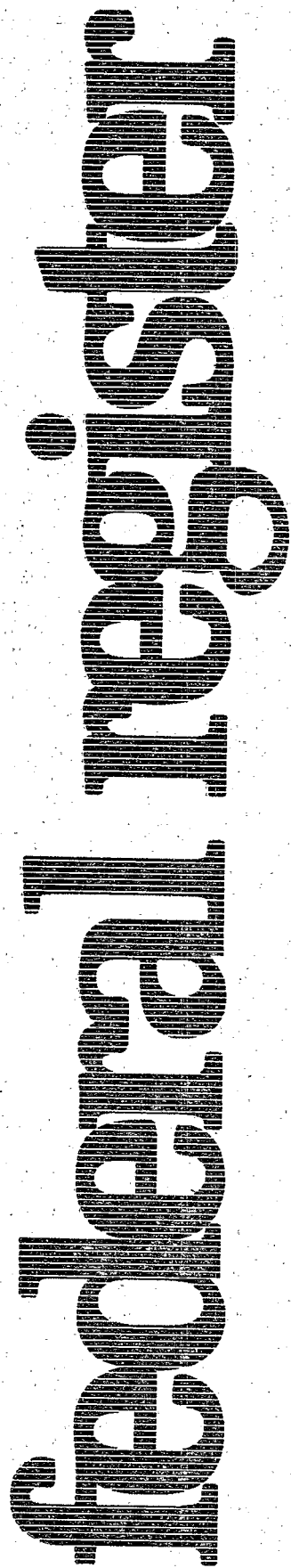Wednesday
August 12, 1987

Part II

Environmental Protection Agency

40 CFR Part 268
Hazardous Waste Management System;
Land Disposal Restrictions; California List
Constituents; Notice of Availability and
Request for Comments

federal register

ENVIRONMENTAL PROTECTION AGENCY

40 CFR Part 268

[SWH-FRL-32409]

Hazardous Waste Management System; Land Disposal Restrictions

AGENCY: Environmental Protection Agency (EPA).

ACTION: Notice of Data Availability and Request for Comment.

SUMMARY: The Environmental Protection Agency is today presenting data and information relating to issues initially noticed for public comment in the December 11, 1986 "California list" land disposal restrictions proposal (51 FR 44714). This information relates to the issues of whether or not to lower the prohibition levels for California list metal-bearing and cyanide-containing wastes, what the lower prohibition levels might be, what treatment standard would be appropriate for these wastes, and whether sufficient national capacity exists to treat these wastes to achieve such standards. This notice provides treatment data corroborating that existing treatment technologies can achieve the suggested prohibition levels for California list metal and cyanide wastes. In addition, the notice includes estimates on the volume of metal and cyanide wastes that would require alternative treatment capacity, and requests additional data and comments on the volumes of wastes that would be affected if EPA lowers the prohibition levels. Furthermore, the Agency is seeking comment on existing treatment capacity and on the time needed to develop new capacity.

This action relates to the requirements of section 3004(d) of the Resource Conservation and Recovery Act (RCRA) which directs EPA to substitute more stringent concentration levels where necessary to protect human health and the environment. The information and comments we receive will be used to aid the Agency in developing final regulations to implement land disposal prohibitions for California list metal and cyanide wastes.

Today's notice also solicits comment on the issue of appropriate pocedures for processing requests for § 268.44 variances from the treatment standard.

DATE: Comments on this notice of data availability and request for comment must be received on or before October 13, 1987.

ADDRESSES: The public must send an original and two copies of their comments to EPA RCRA Docket (S-212), Office of Solid Waste (WH-562), U.S. Environmental Protection Agency, 401 M Street, SW., Washington, DC 20460. Place the Docket Number F-87-LDR6-FFFFF on your comments. The OSW docket is located at: EPA RCRA Docket (LG-100) 401 M Street, SW., Washington, DC 20460. The docket is open from 9:00 a.m. to 4:00 p.m. Monday through Friday, except for Federal holidays. The public must make an appointment to review docket materials. Call at 475-9327 for appointments. The public may copy a maxium of 50 pages of material from any one regulatory docket at no cost. Additional copies cost $.20/page.

FOR FURTHER INFORMATION CONTACT:
For general information about this notice, contact the RCRA Hotline, Office of Solid Waste (WH-562), U.S. Environmental Protection Agency, 401 M Street, SW., Washington, DC 20460, (800) 424-9346 (toll free) or (202) 382-3000 in the Washington, DC metropolitan area.

For information on specific aspects of this notice, contact: William B. Fortune, or Stephen R. Weil, Office of Solid Waste (WH-562B), U.S. Environmental Protection Agency, 401 M Street, SW., Washington, DC 20460, (202) 382-4770.

SUPPLEMENTARY INFORMATION:

I. Background

On December 11, 1986 (51 FR 44714), the Agency proposed to codify the statutory levels for the California list wastes as set forth in section 3004(d) of the Hazardous and Solid Waste Amendments to the Resource Conservation and Recovery Act (RCRA). In this proposal, the Agency also requested comments and data on an alternative approach that would support lowering the restriction levels for those metals for which Extraction Procedure (EP) toxicity characteristic levels exist. In addition, the Agency requested comment on whether the statutory levels should be lowered for hazardous wastes containing the constituents (nickel, thallium, and cyanides) not covered by the EP toxicity characteristic. 51 FR 44722.

Most of the comments submitted in response to the proposed rule supported codifying the statutory levels, particularly for metal-bearing wastes. These commenters indicated that EPA should not lower the prohibition levels unless it can be demonstrated that the statutory limits are not protective of human health and the environment. Commenters asserted that prohibiting the California list metals at EP toxicity levels (levels at which wastes cannot be managed in Subtitle D facilities) would indicate that Subtitle C landfills do not provide additional protection beyond Subtitle D landfills.

A number of commenters, however, urged the Agency to substitute more stringent prohibition levels for California list metal-bearing wastes. The commenters asserted that the statutory levels are 10,000 times the National Interim Primary Drinking Water Standards (NIPDWS), and as such, are not protective of human health and the environment. The commenters further claim that the affected units receiving these wastes are, at least in some cases, unlined surface impoundments (liquids cannot be disposed in landfills) which are not significantly more protective than Subtitle D facilities. Several of these commenters stated that EPA has available data that support setting lower levels (e.g., data in delisting petition files). They also asserted that it is technologically possible to treat metal-bearing wastes to lower levels, and further, that there is substantial unused capacity for treatment of both metal- and cyanide-bearing California list wastes.

In today's notice, the Agency is requesting further comment on lowering the statutory levels for the liquid hazardous wastes containing the California list metals to levels 100 times the NIPDWS in the filtrate of these wastes (i.e., levels found in the liquid portion by running the Paint Filter Liquids Test), and is providing more information on the substantive basis for such a decision. The Agency also is making available data that could support prohibition levels for nickel, thallium, and cyanide, for which no drinking water standards exist. Should the Agency promulgate prohibitions based on these findings, it would also be necessary to promulgate treatment standards under RCRA section 3004(m). Therefore, the Agency is also presenting data that indicates that metal-bearing and cyanide-containing California list wastes can be treated to achieve the EP or analogous levels (for those constituents for which there are no EP toxicity levels). In addition, the Agency is seeking comment on available alternative treatment and volumes of wastes that could be affected should the Agency finalize a rule lowering prohibition levels and establishing treatment standards.

II. Establishing More Stringent Concentration Levels

A. Rationale for Lowering the Prohibition Levels

Section 3004(d)(2) of RCRA indicates that EPA "shall substitute more stringent concentration levels" for those in the statute "when necessary to protect human health and the environment". As mentioned earlier, the Agency proposed to codify the statutory levels, and at the same time solicited comment on whether it should substitute more stringent concentration levels. 51 FR 44718.

Some commenters suggested that EPA has to make a quantified demonstration that the statutory levels are not protective in order to lower the levels. As indicated in the December 11, 1986 proposed rule (51 FR 44718), the statute and legislative history suggest that the decision in many ways is as much a question of policy as a question of fact. The levels in the California list were adopted essentially for reasons of administrative convenience H. Rep. No. 198, 98th Cong., 1st Sess., 35 (1983). The legislative history states that:

[T]hese hazardous wastes and specified concentration levels were selected primarily because the State of California has conducted a rulemaking procedure and begun implementing restrictions on these wastes. The specified concentration levels—10,000 times the Interim Primary Drinking Water Standards—are a conservative starting point for the analysis. The specified concentrations are not intended to be binding on the Agency. (S. Rep. No. 284 at 17)

The legislative history further expresses concerns that the statutory levels are too high, and authorizes the Agency to substitute more stringent levels, when deemed necessary. This language suggests that the decision in some ways involves the choice of a starting point, largely a policy choice. The Senate report indeed emphasizes (in the context of making any land disposal restriction determinations) the Agency's general discretion to prohibit hazardous wastes:

[T]he Agency should not start from the point of having to justify the imposition of a land disposal restriction: The presumption is that land disposal is the least preferred management method. This makes the Agency's decision far simpler than if the Act were neutral as to different management options. The Agency should not start from an assumption that it must begin a new research effort or regulatory analysis before any determinations can be made. (S. Rep. No. 284 at 18)

Not only does section 3004(d) clearly allow the Agency to substitute more stringent levels, but a further indication in the statutory structure confirming the

Agency's discretion to do so is that any such decision could be characterized as an action taken under the independent authority of section 3004(g). Such a decision—an Agency choice of the order in which to implement its delegated authority—is largely discretionary. In any case, the existence of the overlap with section 3004(g) indicates that disputes over the Agency's choice in lowering levels is in many ways a semantic battle over the means used to achieve the result, a situation where there is particular deference afforded to the Agency's choice. *CMA* v. *NRDC*, 105 S.Ct. 1105, 1112 (1985).

In consideration of this statutory language and legislative history, the Agency requested comment on lowering the statutory levels to the EP toxicity characteristic or similar levels (which are 100 times the NIPDWS or analogous levels as opposed to 10,000 times these concentrations). 51 FR 44716. Furthermore, a change in these levels is supported by the statutory findings of the inherent uncertainties and lack of safety of land disposal (see RCRA sections 1002(b)(7) and 3004(d)(1)(A)), and that the only land disposal units that can receive untreated prohibited waste and be deemed protective of human health and the environment for purposes of the land disposal restrictions program are those satisfying the statutory "no migration" standard (section 3004(d)(1)). When one further considers that these constituents are highly mobile (since they are contained in liquids), indefinitely persistent (except for cyanides), and very toxic (see section 3004(d)(1)(c)), it appears that the statutory prohibition levels require further evaluation.

Commenters on the December 11, 1986 proposed rule stated that more stringent levels are needed to protect human health and the environment. Their reasoning was that, as liquids, these wastes would be managed in surface impoundments since there are already prohibitions on the disposal of liquids in landfills (a statutory provision under RCRA section 3004(c), codified on July 15, 1985, prohibits the placement of bulk or non-containerized liquid hazardous waste or free liquids contained in hazardous waste in any landfill). Surface impoundments generally pose a greater potential for migration out of a unit than do other land disposal units because of the higher liquid head and larger volume of liquids within these units. Moreover, many currently operating interim status surface impoundments are unlined or inadequately lined and thus, the potential for downward seepage of contaminated fluids into ground water is

high. A modeling analyses used to evaluate the benefits of proposed leak detection requirements indicated that dissolved constituents can be released at relatively high rates from unlined surface impoundments (May 29, 1987; 52 FR 20270). Of course, there are many cases of ground water contamination resulting from management of waste in surface impoundments that lack proper design and operation. Given the fact that these wastes will often be disposed of in unlined or inadequately lined hazardous waste impoundments, the Agency believes it is appropriate to evaluate whether such disposal at the statutory concentration levels would be protective of human health and the environment.

Release of contaminants in high concentrations could result in human exposure far in excess of health-based levels. The generic land disposal and ground water transport models utilized by the Agency to make policy decisions and for regulatory purposes (e.g., EP model, May 19, 1980, 45 FR 33110; Vertical and Horizontal Spread (VHS) model, November 27, 1985, 50 FR 48886) employ dilution/attenuation factors that estimate the reduction in concentration that would occur as toxicants are transported in ground water from a disposal unit to the point of exposure. The predicted degree of attenuation and dilution is insufficient to prevent exposure to high levels of contaminants.

For the above reasons, the Agency believes that disposal at the statutory levels could result in migration of hazardous constituents from land disposal units that is not protective of human health and the environment. Under such circumstances, the commenter argue that the Agency's obligation is to substitute more stringent concentration levels. The Agency solicits comment on this tentative conclusion.

B. Suggested Prohibition Levels

In the December 11, 1986 proposed rule, the Agency solicited comment on lowering the statutory levels for those metals for which EP toxicity levels exist and on whether the statutory levels should be lowered for wastes other than those for which EP levels are established. 51 FR 44716 (see also 51 FR 44718). The Agency is considering promulgating prohibitions on the California list metal and cyanide wastes at levels 100 times the NIPDWS (or the analogue, in the case of nickel, thallium, and cyanide) and is today making available data to support these earlier statements. These levels are similar (or in the case of true liquids, identical) to

the current EP toxicity concentrations. Liquid wastes that exceed these concentration levels are defined as hazardous and, therefore, are prohibited from disposal in a sanitary landfill or other type of Subtitle D facility. Most commenters who urged the Agency to lower the prohibition levels favored this alternative. For the California list pollutants for which there is no NIPDWS, namely nickel, thallium, and cyanides, levels at 100 times a minimum health level would also be appropriate. 51 FR 44722. (See section III which discusses appropriate minimum health levels for these contaminants.) The Agency, therefore, is contemplating an approach whereby California list hazardous waste containing greater than 100 times the NIPDWS (or 100 times health based levels for nickel, thallium and cyanides) would be considered prohibited from land disposal (until pretreated, disposed of in a "no migration" unit, or granted a variance). [See Table 1].

In taking this position, EPA again does not believe that the statute requires a hard-and-fast quantification that substituted levels are needed to protect human health and the environment. This is because Congress has already determined that, for purposes of the land disposal restrictions program, disposal of untreated hazardous waste is only protective in "no migration" units. Congress also structured the Act in such a way that any substantial levels could be characterized as a section 3004(g) rule justifiable by reference to the factors in section 3004(g)(2), which do not require quantified showings. Rather, what is involved is a determination of an appropriate regulatory starting point. The Agency's tentative view is that given the high degree of toxicity and highly mobile form of the California list metals and cyanides, it may be necessary to prohibit these wastes at concentration levels which normally define liquid waste containing these constituents as hazardous.

California list cyanide and metal waste must be liquids, or contain free liquids. EPA has interpreted this statutory language to mean that the waste must fail the Paint Filter Liquids Test (PFLT), and that in determining if such a liquid waste is prohibited, one measures the constituent concentration level in the filtrate from the waste. 52 FR 25765. EPA is contemplating using this same approach for purposes of determining compliance with lower prohibition levels (since the Agency is construing the same statutory language). The Agency is not defining prohibition levels by reference to concentration

levels in the EP extract from these wastes. In addition, commenters to the proposed rule urged the agency to avoid use of a simulated leach test (in the case of the proposal, the Toxicity Characteristic Leaching Procedure) to determine if a waste was prohibited. On the one hand many commenters felt such a test inappropriate because it did not suitably model all environmental conditions. Other commenters believed the test is insufficiently aggressive because of a dilution feature incorporated in the test protocol, which is also part of the EP toxicity test. Although the Agency does not necessarily agree with these commenters, they do point up reasons why use of an extraction feature in determining which wastes are prohibited might not represent a reasonable regulatory starting point.

TABLE 1.—HEALTH-BASED LEVELS AND SUGGESTED PROHIBITION LEVELS FOR CALIFORNIA LIST METALS AND CYANIDES (MG/L)

Constituent	NIPDWS	Alternative health-based level [a]	Suggested prohibition level (in PFLT filtrate)
Arsenic	0.05	–	5.0
Cadmium	0.010	–	1.0
Chromium	0.05	–	5.0
Lead	0.05	–	5.0
Mercury	0.002	–	0.2
Nickel	–	0.5	50.0
Selenium	0.01	–	1.0
Thallium	–	0.009	0.9
Cyanide	–	0.2	20.0

[a] These levels represent Reference Dose (RfD) values which are based upon data presented in Section III.

III. Proposed Health-Based Levels for Nickel, Thallium, and Cyanide

Today's notice outlines a possible Agency approach with respect to lowering the prohibition levels for California list liquid hazardous wastes containing metals and cyanides to a concentration that equals 100 times the National Interim Primary Drinking Water Standards (NIPDWS). NIPDWS exist for all these constituents identified in these California list waste streams, except nickel, thallium and cyanide.

In the absence of NIPDWS for nickel and thallium, the Agency indicated on December 11, 1986 (51 FR 44722) that, by analogy, one approach would be to use a level that is 100 times less than the statutory requirements. The statutory levels for nickel and thallium had been

developed by multiplying the Ambient Water Quality Criteria (AWQC) for these constituents by a factor of 10,000 (the apparent rationale used by the State of California). The AWQC, however, are guidance numbers and not enforceable standards like the NIPDWS. Hence, prohibition levels developed which are based on these criteria may not be protective of human health. In today's notice, the Agency considers using a level that is 100 times a health-based number, known as a Reference Dose. This section makes available results from studies considered in developing the Reference Dose values for these constituents. Copies of the studies discussed in this section are available for inspection in the public docket.

A Reference Dose (RfD) is an estimate (with an uncertainty of one order of magnitude or more) of a lifetime daily dose of a substance which is likely to be without significant risk to human populations. The RFD is estimated by dividing the highest test does of a substance which causes no adverse effect (NOAEL: No observed adverse effect level) in appropriately conducted animal studies (human studies may also be used if appropriate) by a scaling factor (uncertainty factor) that converts an apparently safe daily dose for laboratory animals to a presumed safe daily dose for humans. The RfD may also be derived from the lowest observed adverse effect level (LOAEL) in a similar manner. The RfDs would represent the minimum health level upon which prohibition concentrations for nickel, thallium and cyanide could be based.

A. Nickel

1. Reference Dose Determination

The Agency has not established a drinking water standard for nickel at the present time. However, the Agency has developed a lifetime Health Advisory based on a NOAEL of 5mg/kg/day from a 2-year rat feeding study (Ambrose et al., 1976). Health Advisories are not legally enforceable Federal standards, but are useful as informal guidance for protecting public health in cases of emergency spills or contamination situations. In the Ambrose et al. study (1976), rats were fed a diet containing 0, 100, 1000, or 2500 ppm nickel sulfate (0, 5, 50, or 125 mg/kg/day) for 2 years. Body weights were reduced significantly in both male and female rats fed 2,500 ppm nickel ($p < 0.05$) when compared to the controls. At 1000 ppm, body weights were also reduced in both sexes. Heart-to-body weight ratios were significantly

higher and liver-to-body weight ratios significantly lower ($p < 0.05$) in the 1000 and 2500 ppm groups. No significant effects were reported at 100 ppm (5mg/kg/day). Therefore, the NOAEL identified in this study was 5 mg/kg/day (100 ppm). In this study, rat survival was poor, particularly in control rats of both sexes (44/50); this raises some concern about the interpretation of the results. However, a subchronic study by American Biogenics Corp. (ABC, 1986) also found 5mg/kg/day to be a NOAEL which supports the chronic NOAEL (Ambrose et al., 1976).

In addition to the above rat chronic feeding study, there are other chronic studies available in mice, rats and dogs. In the chronic study in mice (Schroeder et al., 1964), where animals were fed a diet devoid of cadmium and low in other elements, no significant effects were observed at 5 ppm (0.85mg/Ni/Kg/day) nickel in drinking water. In the study with rats (Schroeder et al., 1974), 5 ppm nickel (0.41 mg/kg/day) in drinking water for life led to a significant reduction in body weight of both male and female rats compared to controls; life span was not affected but histopathology revealed an increased incidence ($p < 0.025$) of focal myocardial fibrosis (13.3%) in the experimental group compared to the control. However, results of both the above studies are difficult to interpret because the studies used single doses and also because the diets were deficient in other essential minerals. In the 2-year dog study (Ambrose et al., 1976), in which animals were fed a diet containing 0, 100, 1000 or 2500 ppm nickel (0, 3, 29 or 70 mg/kg/day), the NOAEL identified was 29 mg/kg/day (1000 ppm) based on decreased body and liver weights.

Nickel has also been tested for its reproductive toxicity. In the 3-generation rat reproduction study (Ambrose et al., 1976), rats fed a diet containing 0, 250, 500 or 1000 ppm nickel sulfate (0, 12.5, 25 or 50 mg/kg/day) showed increased stillbirths in the first generation, and decreased pup body weight at 50 mg/kg/day (1000 ppm). Increased stillbirths were also observed in the control group. This study had some statistical design limitations, such as small sample size with the use of pups rather than litters as the unit for comparison. Also, the fact that nickel was administered in the diet caused problems when applying these data to drinking water situations. Schroeder et al., (1971) reported a 3-generation reproduction study in rats administered 5 ppm nickel in drinking water (0.43 mg/kg/day). In this study, neonatal mortality was increased

significantly ($p < 0.025$) in all generations of exposed rats compared to controls; the number of runts were increased significantly in the first (F_1) ($p < 0.025$) and third (F_3) ($p < 0.0001$) generations. Average litter size was reduced somewhat in the F_3 generation. The results of this study, however, are difficult to interpret because only 5 pairs of animals were used for mating and the diet was found deficient in trace essential metals (in particular the essential element chromium). Also the results of this study are not reproducible.

Because of the various problems with the available nickel studies (as mentioned earlier), the Agency conducted two studies to determine the effects of nickel on rats. The first study was a 2-generation reproduction study in rats (RTI, 1987) which included a 90-day subchronic non-breeder satellite group. The second was a subchronic gavage study in rats (ABC, 1986).

In the 2-generation reproduction study (RTI, 1987), nickel chloride was administered in drinking water to male and female CD rats (30/sex/group) at dose levels of 0, 50, 250 and 500 ppm (0, 7.3, 30.8, and 51.6 mg/kg/day, estimated) for 90 days prior to breeding. (Ten rats/sex/group comprised a satellite subchronic non-breeder group.) At the 500 ppm dose level there was a significant decrease in the Po maternal body weight along with absolute and relative liver weights. No adverse effect was noted at the 250 ppm level or lower for the Po breeders of the non-breeder satellite. Histopathology was performed on liver, kidney, lung, adrenals, pituitary and reproductive organs to make this assessment.

In the F1a generation (postnatal days 1–4) at the 500 ppm dose level, the number of live pups/litter was significantly decreased, pup mortality was significantly increased, and average pup body weight was significantly decreased in comparison with controls. Similar effects were seen in F1b litters of Po dams exposed to 500 ppm nickel. In the F1b litters of the 50 and 250 ppm dose groups, increased pup mortality and decreased live litter size was seen. However, these effects seen with F1b litters are questionable because the room temperature tended to be 10°F higher than normal at certain times (gestation-postnatal days) along with much lower levels of humidity. As evidenced in the literature, temperatures which are 10°F above the normal during fetal development, cause adverse effects (Edwards, 1986). Therefore, the above results seen at the 50 and 250 ppm dose

cannot be considered as genuine adverse effects.

F1b males and females were randomly mated on postnatal day 70 and their offspring (F2a and F2b) were evaluated through postnatal day 21. This phase included teratological evaluations of F2b fetuses. Evaluation of the data indicated that the 500 ppm nickel dose caused significant body weight depression of both mothers and pups, and increased neonatal mortality during the postnatal development. The intermediate dose, 250 ppm nickel, produced transient depression of maternal weight gain and water intake during gestation of the F2b litters. The 50 ppm nickel caused a significant increase in short ribs (11%). However, since this effect was not seen in the two higher dose groups, the reported incidence of short ribs in the 50 ppm group is not considered to be of biological significance.

In the subchronic study (ABC, 1986), nickel chloride in water (0, 5, 35 and 100 mg/kg/day) was administered by gavage to both male and female CD rats (30 animals/sex/group). The data generated in this study included clinical pathology, ophthalmological evaluations, serum biochemistry, body and organ weight changes and histopathological evaluations of selected organs (heart, kidney, liver).

Clinical signs of toxicity, such as lethargy ataxia, irregular breathing, cool body temperature, salivation and discolored extremities, were seen primarily in the 100 mg/kg group; these signs were less severe in animals of the 35 mg/kg group. The 5 mg/kg groups did not show any significant clinical signs of toxicity. Also, there was 100% mortality in the high-dose group; 6/30 males and 8/30 females died in the mid-dose group (35 mg/kg/day). Histopathological evaluation indicated that 3/6 dead males and 5/8 dead females were due to gavage errors. Body weight and food consumption values were consistently lower than controls for the 35 and 100 mg/kg dosed males. Female rats in both high-dose groups had lower body weights than controls but food consumption was unaffected by the test article. At sacrifice, kidney, liver and spleen weights for 35 mg/kg treated males and right kidney weights for 35 mg/kg treated females were significantly lower than controls. Based on the results obtained in this study, the 5 mg/kg/day nickel dose was a NOAEL, whereas the 35 mg/kg/day was a LOAEL for decreased body and organ weights.

Thus, it can be seen that the chronic NOAEL of 5 mg/kg/day derived from the Ambrose et. al. (1976) study is

supported by the subchronic study by ABC, 1986. Using this chronic NOAEL of 5 mg/kg/day, in uncertainty factor of 100 (10 for the uncertainty in the interspecies conversion and 10 for uncertainty in the sensitive human subpopulations) and a modifying factor of 3, the RfD calculated is 0.02 mg/kg/day (the modifying factor is another uncertainty factor, the size of which depends on the assessment of scientific issues not explicitly addressed by the conventional uncertainty factors). The modifying factor of 3 is used because of inadequacies in the reproductive studies (RTI, 1987; Ambrose et. al. 1976). During the gestation and postnatal development of F1b litters in the RTI (1987) study, temperatures were about 10 °F higher than normal at certain times which makes evaluation of this part of the reproductive study impossible. In the Ambrose et. al. (1976) study, there were some statistical design limitations, such as small sample size and use of pups rather than litters as the unit for comparison.

Based on the above RfD of 0.02 mg/kg/day, the concentration of nickel per liter of water consumed by an adult weighing 70 kg and drinking 2L water per day is 0.7 mg/L. This assumes that 100% of the exposure for nickel is via drinking water. However, it has been shown that the nickel intake from diet is between 350–500 ug/day. Therefore, the Agency apportioned the reference dose assuming an average intake of 400 ug/day from diet. The resulting concentration of nickel in drinking water would be 0.5 mg/L.

2. Proposed health-based prohibition level

Based on the above apportioned RfD of 0.5 mg/L, the Agency would consider promulgating a health-based prohibition level for nickel of 50 mg/L in the filtrate from a waste. This value is derived using the assumptions discussed in the May 19, 1908, FR notice (45 FR 33119) which promulgated the Extraction Procedure Toxicity Characteristic.

B. Thallium

1. Reference Dose Determination

There is no drinking water standard for thallium at the present time. The Agency's Reference Dose Workgroup had verified RfDs for various thallium compounds which ranged from $4 \times 10^{-4} \times 10^{-4}$ mg/kg/day. The RfDs were based on a study by Downs et. al, (1960) in which rats were fed diets containing varying concentrations of thallium acetate for 15 weeks. The NOAEL (No Observed Adverse Effect Level) for thallium indentified in this study was 5 ppm (0.39 mg/kg/day) based on alopecia and increase in kidney weght.

The above study, however, was not adequately performed. There were too few animals per dose group, mortality was very high—100% in the 50 ppm group by week 5, 100% in the 30 ppm group by week 9, and 40% in the control group by week 15, which made interpretation of survival in remaining dose groups difficult. At the 15 ppm level the mortality was ⅗ males and ⅕ females and at the 5 ppm level (the NOAEL) ⅗ males and ¾ females. The Agency, therefore, had thallium sulfate tested in a rat subchronic study by the Midwest Research Institute (1986). This study was carried out according to the EPA Toxic Substances Control Act (TSCA) Toxicity Testing Guidelines (40 CFR 798.2650) and is available for review in the docket to this rulemaking. In this study, Sprague-Dawley rats (20/sex/group) were treated by gavage with an aqueous solution of thallium acetate at concentrations of 0, 0.01, 0.05 or 0.25 mg/kg/day. The NOAEL identified in this study is 0.25 mg/kg/day. Applying an uncertainty factor of 1000 [10 for uncertainty in the subchronic NOAEL (no chronic studies available), 10 for uncertainty in the interspecies coversion and 10 for uncertainty in the sensitive human subpopulations], the RfD is calculated to be 2.5×10^{-4} mg/kg/day. Based on this RfD, the concentration of thallium per liter of water consumed by an adult weighing 70kg and drinking 2L water per day is 0.9×10^{-2} mg/L. This assumes that 100% of the exposure to thallium is via drinking water. The Agency may revise this number if there are relative source contribution data which document human exposure from other sources such as food, air and possibly the occupational environment.

2. Proposed health-based prohibition level

Based on the above RfD of 0.009 mg/L the Agency would consider promulgating a health-based prohibition level for thallium of 0.9 mg/L in the filtrate from a waste. This value is derived using the assumptions discussed in the May 19, 1980, FR notice (45 FR 33119) which promulgated the Extraction Procedure Toxicity Characteristic.

C. Cyanide

1. Reference Dose Determination

There is no drinking water standard for cyanide. The Agency has a life-time health advisory based on a RfD of 0.02 mg/kg/day. The Agency had verified the RfD based on a study by Howard and Hanzel (1955) in which rats were fed diets, for 104 weeks, that had been fumigated with HCN. The average CN concentrations in food were estimated based on the food consumption and body weight. The daily estimated intake of CN was 4.3 and 10.8 mg/kg/day. Using the NOAEL of 10 mg/kg/day, an uncertainty factor of 100 (10 for uncertainty in the interspecies conversion and 10 for uncertainty in the human subpopulations) and a modifying factor of 5 (to account for the apparent tolerance to cyanide when it is digested with food rather than when it is administered by gavage or by drinking water), the RfD calculated was 0.02 mg/kg/day.

The interpretation of data from the Howard and Hanzel (1955) study is difficult because of the route of administration (in the diet rather than in water) and the manner in which the delivered dose was measured (the CN concentration was estimated based on levels measured at the beginning and end of each food preparation period and by assumption of a first-order rate of loss during the intervening period). The Agency, therefore, conducted a subchronic study (IIT Research Institute, 1987), according to the EPA TSCA Toxicity Testing Guidelines (40 CFR 798.2650). The data is available in the docket to this rulemaking.

In this study, Sprague-Dawley rats (20/sex/dose) were administered CuCN in a 1.5% carboxymethylcellulose (CMC) vehicle by gavage at dose levels ninety to of 0, 0.5, 5 15 or 50 mg/kg/day for ninety-three days. The vehicle control group received CMC only. The untreated control group received neither vehicle nor CuCN, but otherwise was handled in a manner similar to that of treatment groups. The NOAEL identified in this study is 5 mg/kg/day based on significant decreases in the body weight and body weight gain, in serum SGOT level, and in organ weights (kidney, spleen and brain). Based on the NOAEL and using an uncertainty factor of 1000 (10 for uncertainty in the subchronic NOAEL, 10 for uncertainty in the interspecies conversion and 10 for uncertainty in the sensitive human subpopulations) the RfD calculated 0.005 mg/kg/day.

Using this RfD, the concentration of cyanide per liter of water consumed by an adult weighing 70 kg and drinking 2L water per day is 0.2 mg/L. This assumes that 100% of the exposure for CN is via drinking water. This number may change if there are relative source contribution data from other sources such as food, air and possible occupational exposure.

2. Proposed health-based prohibition level

Based on the above verified RfD of 0.2 mg/L, the Agency is considering promulgating a health-based prohibition level for cyanide of 20 mg/L in the filtrate from a waste. This value is derived using the assumptions discussed in the May 19, 1980, FR notice (45 FR 33119) which promulgated the Extraction Procedure Toxicity Characteristic.

D. References

(1) Ambrose, A.M., et al. 1976. Long term toxicologic assessment of nickel in rats and dogs. Jour. Food Sci. Technol. 13: 181.

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IV. Establishing Treatment Standards For California List Metals and Cyanides

Statutory Basis for Establishing Treatment Standards

Section 3004(m) of RCRA states that "simultaneously with the promulgation of regulations" prohibiting the land disposal of particular hazardous wastes, EPA shall "promulgate regulations specifying those levels or methods of treatment, if any, which substantially diminish the toxicity of the waste or substantially reduce the likelihood of migration of hazardous constituents from the waste so that short-term and long-term threats to human health and the environment are minimized." Therefore, should the Agency promulgate more stringent prohibition levels, it would also have an affirmative responsibility to establish treatment standards for these metal-bearing and cyanide-containing wastes.

V. Treatment Technology Performance Data Analysis

Several commenters on the December 11, 1986 proposed rule stated that California List metal-bearing and cyanide-containing wastes could be treated below the statutory prohibition levels, and a number of them indicated that treatment at least to levels comparable to the EP regulatory levels were achievable for metals. Specifically, these commenters pointed to delisting petitions and Agency studies as sources of data supporting their positions. In addition, one commenter provided treatment data on California List metals.

In response to the above-mentioned comments, the Agency performed a series of treatment performance data analyses. This section presents the Agency's methodology for performing these analyses, all available treatment data, a discussion of its limitations, and the conclusions derived from the data.

A. Data Analysis Methodology

1. Data Compilation

The Agency's initial activity was to identify data sources germane to a re-analysis of waste treatment of metals and cyanides. This activity included (1) analyzing delisting petitions, (2) reviewing petitions submitted subsequent to the original analysis performed for the proposed rule, (3) assessing Agency data collected in support of other regulatory programs, (4) reviewing available literature, and (5) analyzing data contained in comments submitted in response to the proposed rule. The Agency assembled all data on metals and cyanide treatment regardless of whether the wastes involved would

have been classified as a California List waste.

Two criteria were used to edit the data. The First editing rule was that the untreated waste concentration in wastewater for the California List metals and cyanide had to be greater than the EP regulatory levels or health-based prohibition levels. Similarly, leachates from untreated wastes other than wastewaters had to have concentrations greater than the EP regulatory levels or health-based prohibition levels. If leachate data were not available for untreated wastes other than wastewater, the untreated waste concentration for the various metals and cyanide had to be greater than 20 times the EP regulatory levels or health-based prohibition levels. This second editing rule reflects the inherent dilution factor of the EP Toxicity (or TCLP) test. For example, if a raw sludge contained 800 mg/kg of nickel, the EP Toxicity test leachate would have a maximum value of 40 mg/1 (or $\frac{1}{20}$ of the value of the original composition). The 40 mg/1 value assumes no treatment and 100 percent leaching of nickel from the waste. The two editing rules were necessary to ensure that all data evaluated are appropriate for making a determination of whether a waste can be treated to a particular level. It is important to note that for most of the delisting data, leachate values were not available for the untreated wastes; in these cases, EPA included the raw waste and treated waste data set provided that the untreated waste concentration was more than 20 times the EP regulatory levels or health-based prohibition levels.

2. Data Analysis

For each treatment data point, the Agency assessed the specific waste characteristic data that would affect the performance of the technology used to treat the waste. Additionally, the Agency analyzed the pertinent design and operating data associated with the performance of the treatment technology. The specific parameters the Agency included in its analysis can be found in the Applicable Technologies, Section V(B).

The Agency notes that in analyzing these data, it is unable to use the methodology for deriving BDAT levels outlined in the November 7, 1986 solvent rule (51 FR 40590–592). This methodology presupposes a data set from treating relatively well-defined waste treatability groups. California List wastes, however, area a much more diverse set or wastes, containing numerous potential waste treatability groups (51 FR 44727, December 11, 1986).

EPA is not able to establish discrete treatability groups at this time for California List wastes, and consequently is unable to use the November 7 methodology in analyzing these data. Nor is the Agency using these data to derive treatment levels. The data are instead being used as a means of corroborating the Agency's engineering judgment and commenters' assertions that treatment standards reflecting EP regulatory levels (or comparable levels for nickel, thallium, and cyanides) are achieveable.

As additional data are developed for individual metal and cyanide waste streams, the Agency will revise these prohibition levels accordingly. This could be done either pursuant to Section 3004(g) authority, or possibly through analysis of data and other information submitted in response to this notice. Thus, treatment standards under consideration in this notice will serve as an interim measue until EPA re-evaluates these wastes according to the final schedule for land disposal restrictions which was promulgated on May 28, 1986 (51 FR 19300). Should EPA issue a final rule establishing the types of treatment standards discussed here, the Agency would thus characterize its action as a type of interim BDAT (i.e., a treatment standard, in the Agency's judgment, attainable for a very wide spectrum of California List wastes but subject to later reevaluation as individual waste treatability groups and treatment performance on such treatability groups become better defined).

Finally, the Agency notes that the treatment standards under consideration for metal-bearing and cyanide-containing wastes most likely would be expressed as either concentrations in the waste or treated residue using the EP toxicity test or the Toxicity Characteristic Leaching Procedure (TCLP). The Agency's use of the EP toxicity test for purposes of determining compliance will the treatment standards would be consistent with the analytical methodology used for the data that the Agency is examining and noticing for comment. An alternative approach would be to consider use of the TCLP (Appendix I to Part 268-Land Disposal Restrictions; 51 FR 40572, November 7, 1986). Currently, the Agency is reviewing the TCLP to determine if it produces results for these wastes that approximate those from the EP toxicity test. The Agency is requesting comment on the applicability of these possible approaches for purposes of determining compliance with the treatment standards.

B. Applicable Technologies

This section describes the technology and its application, the chemical/physical mechanisms by which treatment is accomplished, the various waste characteristics that affect treatment, and finally the design and operating parameters that are important in optimizing treatment of a particular waste.

The technologies presented below are the technologies that we believe are most applicable to the treatment of California List metals and cyanide. They are: chemical precipitation, stabilization, chromium reduction, cyanide oxidation, high temperature metal recovery, filtration, sludge dewatering, and ion exchange.

1. Chemical Precipitation

a. *Description and Applicability.* Chemical precipitation refers to both the primary step of forming a chemical precipitate and follow-up operations that separate the solid precipitate from the liquid. Equipment required to operate a chemical precipitation system includes the following: a stirred reaction tank, feed systems to introduce treatment chemicals and/or flocculant aids, a settling tank or clarifier, and possibly filtration or centrifugation equipment.

The chemical precipitation treatment technology can be applied to a wide range of wastewaters that contain California List metal wastes.

b. *Basic Principle of Operation.* The basic operating principle of this technology is to chemically convert metal compounds from a soluble to an insoluble form and then to remove the precipitate by settling or other physical separation.

The principal chemicals used to convert soluble metal compounds to the insoluble form are lime ($Ca(OH)_2$), caustic (NaOH), sodium sulfide (Na_2S), and, to a lesser extent, soda ash (Na_2CO_3) and ferrous sulfide (FeS). Removal of the chemical precipitate is generally accomplished by gravity settling, clarification, and/or filtration.

c. *Waste Characteristics Affecting Performance.* The level of metals removal achieved by chemical precipitation treatment may depend on a number of waste characteristics, which include:

- The valence state of the metal;
- Other metals present in the waste;
- Whether the metal exists as a complex;
- High concentrations of dissolved inorganic solids in solution (i.e., salinity);
- Presence of oil and grease in the waste; and the
- Presence of surfactants in the waste.

As shown in Figure 1, for many metals there is a specific pH at which the metal is least soluble (other waste characteristics including temperature and pressure being equal). Also, many metals are amphoteric, meaning that there are both lower and higher pH values at which the metal is more soluble. As a result, when metals are mixed, it is not possible to operate a treatment system at a single pH value that is optimum for all metal removals. Certainly, improved treatment can result from multiple precipitations at a number of pH settings, but it may still be difficult with some combinations of metals and associated concentrations to achieve close to optimum performance.
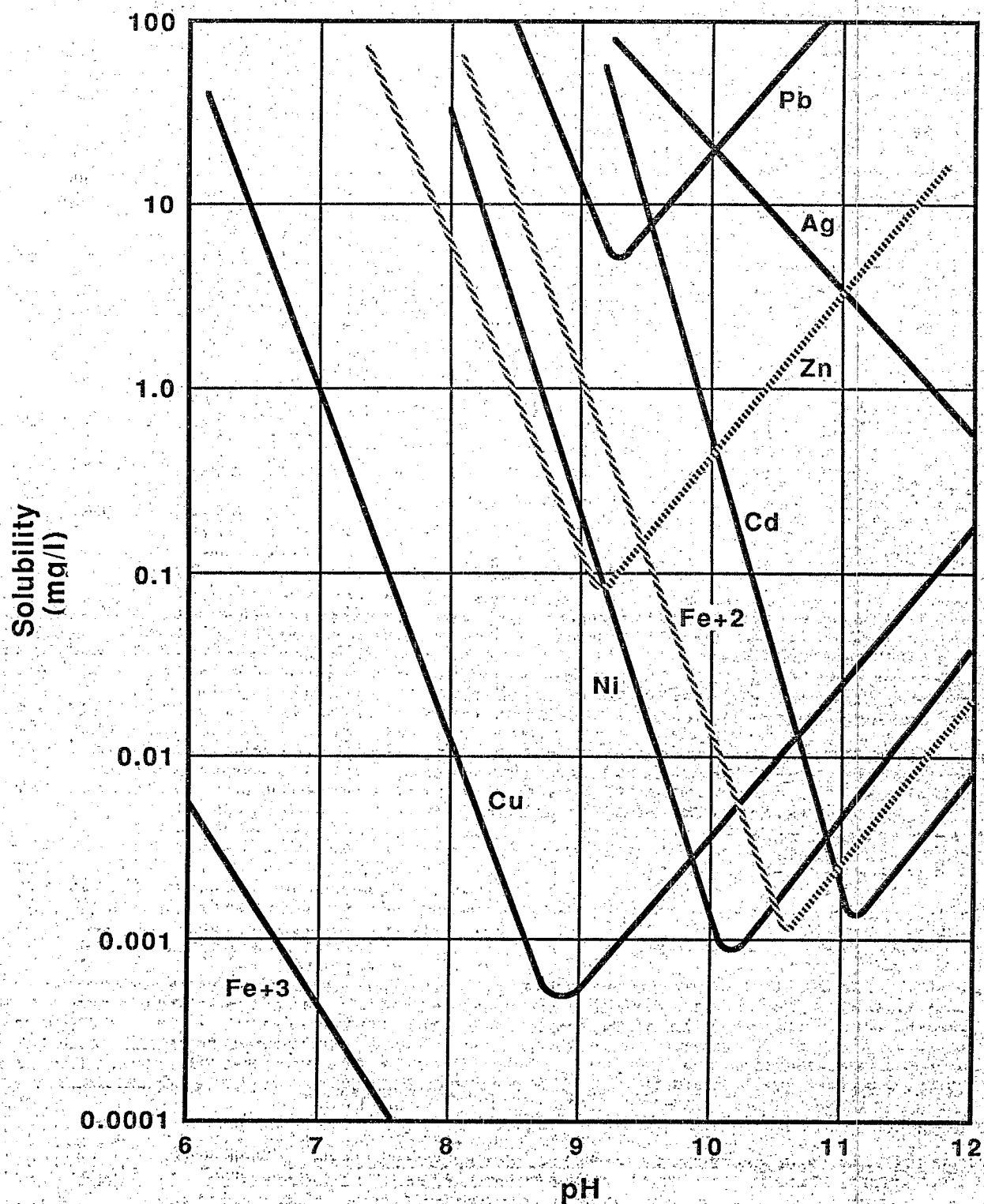
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Figure 1.   Solubilities of Metal Hydroxides as a Function of pH

Metal complexes consist of a central metal ion surrounded by a group of other organic or inorganic ions or molecules. Examples of complexing molecules are ammonia, amines, methanol, and EDTA. The presence of complexing ions or molecules in solution will generally increase the solubility of a metal by reducing the chemical potential of the free metal ions to combine with precipitating anions such as hydroxide. When metal complexes are present in solution, only a fraction of the total dissolved metal is in free form (i.e., available for the precipitation reaction). Wastes containing complexed metals generally need to be treated at high pH in order to break the complexes and transform the metals to a less-soluble form amenable to chemical precipitation. The degree to which the complexes can be broken may be limited by the equilibrium conditions that exist even at the higher pH.

High concentrations of inorganic dissolved solids may interfere with the precipitation reactions. Higher pH values may be needed to achieve metals removal in these cases.

The presence of oil and grease or surfactants in the waste may also affect the settling characteristics of the solids by creating emulsions that require a long settling time. Removal of these constituents (for example, by thermal emulsion breaking prior to the chemical precipitation step should eliminate this problem.

d. *Design and Operating Parameters Affecting Performance.* The design and operating variables that the Agency evaluates for chemical precipitation systems, to the extent possible, are:

• The specific treatment chemical used to effect precipitation;
• pH;
• Temperature;
• Settling time;
• Feed rate to the settling tank;
and, if filtration is used;
• Pore size; and
• Feed rate to the filter.

(i) The type of reagent is important because these chemicals affect the solubility and settling characteristics of the various precipitated metal compounds.

(ii) The design and control of pH is important because pH is used as a surrogate for reaction completion. In addition, sulfide reagents may cause emission of toxic gases if pH is not properly controlled. In a batch system, control is less difficult than in a continuous system. A continuous system requires a fairly sophisticated automatic control system in order to keep the pH in a relatively narrow range. To the extent possible, the Agency prefers to

have continuously recorded data to ensure that the pH is maintained in the proper range during the treatment process.

(iii) Temperature has an effect on the solubility of the chemical precipitate; therefore, the Agency needs to have data on temperature during the treatment process. Unlike pH, the temperature is inherently more stable and data collection can be significantly less frequent. Most chemical precipitation processes are conducted at ambient temperatures.

(iv) Design and control of settling time is important because there are a number of physical parameters that affect how quickly a particle settles. These include the density, shape, and size of the particle.

(v) To ensure that the design settling rate is being maintained during treatment, it is important to have feed rate data.

(vi) Filtration can be used in conjunction with settling or separately. In either case, the Agency needs to know the design pore size and the basis for that determination.

(vii) The Agency also needs data on flow rate to ensure that the operation of the filter is within design specifications during treatment.

2. Stabilization

a. *Description and Applicability.* Stabilization refers to a broad class of treatment processes that physically or chemically reduce the mobility of hazardous constituents in a waste. Other terms that are sometimes used synonymously for stabilization are solidification and fixation. The stabilization treatment system consists of a feed system, a tank equipped with mixing equipment, and a cure area.

This technology has wide application to California List metal wastes. In most instances, the technology is used where the wastes of interest already contain a significant percentage of solids, e.g., metal precipitates in a treatment sludge. Stabilization can be applied to wastewaters.

b. *Underlying Principles of Operation.* The underlying principle of stabilization is the binding of constituents of concern into a solid that is resistant to leaching. The mechanism by which this occurs depends upon the type of stabilization process. Two of the most common are lime/pozzolan-based processes and portland cement-based processes.

In portland cement systems, the waste is mixed in a slurry with anhydrous cement powder, water, and, frequently, pozzolanic additives. The cement powder is a mixture of powdered oxides of calcium, silica, aluminum, and iron

produced by kiln burning materials rich in calcium and silica at high temperatures. The major mechanism of stabilization in this system is the formation of hydration products from silicate compounds and water. A calcium silicate hydrate gel forms. This gel then swells and forms the cement matrix composed of interlocking silicate fibrils. At the same time, constituents present in the waste slurry, e.g., hydroxides of calcium and various heavy metals, form the interstices of the cement matrix. Metal ions may also be incorporated into the crystal structure of the cement matrix itself. A rigid mass results from the interlocking fibrils and other components during setting and curing.

Lime/pozzolan processes use the finely divided, noncrystalline silica in pozzolanic material (e.g., fly ash) and the calcium in lime to produce a concrete-like solid of calcium silicate and alumino hydrates. The waste containment is achieved by entrapping the waste in this pozzolan concrete matrix. In actual operation, the waste, water, and a selected pozzolanic material are mixed to a pasty consistency. Hydrated lime is blended into the mixture and the resulting moist material is packed or compressed into a mold and cured over a sufficient time interval.

c. *Waste Characteristics Affecting Performance.* The level of performance for stabilization processes is measured by the amount of constituents that can be leached from the stabilized material. There are two techniques currently recognized by the Agency as measures of leachability. The first is the Extraction Procedure (EP) Toxicity Test (40 CFR 261); the second is the Toxicity Characteristic Leaching Procedure (TCLP) (51 FR 40643, November 7, 1986).

Several waste characteristics affect performance. In the lime/pozzolan system and in the portland cement system, oil, grease, and very fine insoluble materials (i.e., 74×10^{-6} meter particle size) can weaken bonding between waste particles and cement by coating the particles. The presence of certain inoganic compounds (e.g., sodium borate and calcium sulfate) will also interfere with the cementitious reactions, prolonging setting and curing time and weakening bond strenght. Soluble salts of copper, lead, manganese, tin, and zinc may cause large variations in setting and curing time and reduce the dimensional stability of the cured matrix, thereby increasing leachability potential. The presence of certain organic compounds may likewise interfere. In portland

cement systems, large amounts of sulfates will impede setting and react to form calcium sulfuluminate hydrate, causing swelling and spalling of the stabilized product.

d. *Design and Operating Parameters Affecting Performance.* The design and operating parameters that the Agency evaluates, to the extent possible, are:

• Selection of stabilizing agents and other additives;

• Ratio of waste to stabilizing agents and other additives;

• Mixing; and

• Cure conditions.

(i) The type of stabilizing agent selected and the use of additives will determine the bonding and structure of the stabilized waste solid and, therefore, have an effect on how well waste constituents are incorporated into the solid. Stabilizing agents and other additives must be carefully selected based on the chemical and physical characteristics of the waste to be stabilized. For example, the amount of sulfates in a waste will come into consideration when choosing a lime/pozzolan over portland cement-based system. Lime/pozzolan or a special low alumina, sulfate-resistant cement would be the stabilizing agent of choice, as it would prevent swelling and spalling in the stabilized product. Waste-solidifying formulations in stabilization processes vary widely, and a variety of materials may be used in conjunction with the stabilizing agent to change performance characteristics. These include soluble silicates, hydrated silica gels, clays, emulsifiers, surfactants, carbon, and zeolites. In portland cement systems, soluble silicates will reduce the interference from metal ions in the waste. Emulsifiers and surfactants will allow the incorporation of immiscible organic liquids. Carbon, silicates, and zeolites will adsorb toxic constituents and be encapsulated within the stabilized solid.

(ii) The amount of stabilizing agents and other additives is a critical parameter in that sufficient stabilizing materials are necessary in the mixture to bind the waste constitutents of concern properly, thereby making them less susceptible to leaching. The appropriate ratios of amounts of waste to stabilizing agent and other additives are established after evaluating the waste and the selected stabilization formulation. This may be done by setting up a series of experiments that allow separate leachate and strength testing of different mix ratios. Once established, the ratios are maintained by monitoring the volume and/or weight of the waste and the stabilizing agents

and other additives through the use of feed systems.

(iii) The conditions of mixing include the type and duration of mixing. Mixing is necessary to ensure adequate distribution of the waste and the stabilizing agents, thereby resulting in uniform bonding. Insufficient mixing could result in some of the waste constituents of concern not being bound in the solid and thus being susceptible to leaching.

(iv) The conditions of cure include the duration of curing and the ambient curing conditions (temperature and humidity). The duration of curing is a critical paramenter to ensure that the waste particles have had sufficient time in which to form a stable solid. The time ncessary for complete stabilization to occur depends upon the waste type and the treatment process used. The performance of the stabilized waste (i.e., the levels of constitutents in the leachate) will be highly dependent upon whether complete stabilization has occurred. Curing conditions such as ambient temperature and humidity affect the rate of curing and, therefore, could affect the strength of the stabilized solid.

3. Hexavalent Chromium Reduction

a. *Description and Applicability.* The process of hexavalent chromium (Cr^{6+}) reduction involves conversion from the hexavalent form to the trivalent form of chromium. The treatment system essentially consists of a stirred tank with a feed system for adding a "reducing agent" and a system for adding a chemical to adjust pH. This technology has wide application to hexavalent chromium wastes including plating solutions, stainless steel acid baths and rinses, "chrome conversion" coating process rinses, and chromium pigment manufacturing wastes. It is important to note that additional treatment is required to remove trivalent chromium from solution.

b. *Basic Principles of Operation.* The basic principle of treatment is to reduce the valence of chromium in solution (in the form of chromate or dichromate ions) from the valence state of six to the trivalent (+3) state. "Reducing agents" used to effect the reduction include sodium bisulfite, sodium metabisulfite, sulfur dioxide, sodium hydrosulfide, or the ferrous form of iron.

c. *Waste Characteristics that Affect Performance.* The Agency believes that the single waste characteristic that most affects performance of chromium reduction treatment is the presence of other reducible compounds in the waste. Substances such as oils and other metal ions may exhibit a demand for the

reducing agent used to treat hexavalent chromium. In these cases, additional reducing agent must be added to satisfy the extra demand. To ensure that enough reducing agent is employed in the batch system, the hexavalent chromium concentration is monitored after completion of treatment. In continuous systems, oxidation-reduction potential (ORP), a surrogate for hexavalent chromium concentration, is measured and controlled.

The literature indicates that solutions of hexavalent chromium up to 1,300 ppm have been treated successfully using reduction technology. More concentrated solutions should be bench tested prior to application of the reduction technology. Additional retention time may be required for satisfactory treatment.

d. *Design and Operating Variables Affecting Performance.* Four design and operating variables that the Agency believes are critical to proper operation are:

• pH control;

• Control of reducing agent feed quantity;

• Type of reducing agent used; and

• Retention time.

(i) The specific pH value chosen (usually acidic) is a function of the reducing agent used. In a batch system the value need not be adhered to rigorously (i.e. within ±1 pH unit) because the reaction will be completed rapidly even with slight variations. Reaction completion is determined, in any case, by measuring hexavalent chromium levels prior to further processing. In continuous systems, however, where oxidation-reduction potential (ORP) sensors are used to control feed of the reducing agent, pH must be controlled precisely, since the ORP value will vary with pH changes.

(ii) In continuous systems, the ORP value is used as a surrogate for the degree of hexavalent chromium treatment, and controls the feed of reducing agent. If the ORP is not controlled in a fairly precise range, insufficient reducing agent may be fed to treat the hexavalent chromium.

(iii) Various reducing agents are available (see Basic Principles of Operation section). Economics and availability usually dictate their use, not the ability to reduce hexavalent chromium. Certain reducing agents will require higher dosage rates than others. Also, some will produce greater quantities of settled solids (such as ferrous iron, which also precipitates ferric hydroxide). Sulfur dioxide, when used as a reducing agent, may liberate

sulfur dioxide gas if not properly maintained and controlled.

(iv) Retention time should be adequate to ensure that the hexavalent chromium reduction reaction goes to completion. In the case of the batch reactor, the retention time is varied by adjusting treatment time in the reaction tank. If the process is continuous, the retention time may be varied by changing flow rates of feed and reagent to the reaction tank.

4. Cyanide Oxidation

a. *Description and Applicability.* Cyanide oxidation is a treatment process which chemically destroys free cyanides found in solution. The cyanide is converted either to a cyanate form or to carbon dioxide and nitrogen. This treatment system consists of a stirred tank or tanks and feed systems for an oxidizing agent and a chemical used to adjust pH.

This technology can be applied to a wide range of cyanide wastes such as those generated from plating copper, zinc and brass; solutions generated by rinsing of residues from cyanide salt heat treating baths; and cyanide metal "passivating" solutions and rinses. In some solutions, however, cyanide is tightly bound to dissolved metals, such as iron, by chemical complexing (i.e., the metal and the cyanide are not easily separated). Therefore, the metal cyanide complex becomes less amenable to chemical oxidation. For some of these "complexed" forms of cyanide, the preferred treatment technology is cyanide precipitation.

b. *Basic Principles of Operation.* In the cyanide ion, the carbon and nitrogen atoms are bound by what is referred to as a triple bond, represented by $-C\equiv N$. When sufficient oxidizing agent is present, the cyanide ion is converted to a cyanate ion, represented by $-O-C\equiv N$ or $O=C=N-$. Further treatment, if used, breaks the triple bond form of cyanate and converts both forms of the cyanate to carbon dioxide and nitrogen gas. The two types of oxidizing agents used most frequently are chlorine-containing materials (e.g., chlorine gas, sodium hypochlorite, or calcium hypochlorite) and ozone gas. A typical reaction showing sodium hypochlorite reacting with sodium cyanide to form sodium cyanate is:

$NaCN + NaOCl \rightarrow NaCNO + NaCl$.

c. *Waste Characteristics Affecting Performance.* The two waste characteristics that affect performance are the presence of metals and the presence of other oxidizable materials. As noted earlier, many metals form complexes with free cyanide.

Complexes of many of the metals, including iron and to some extent nickel, cannot be decomposed by cyanide oxidation techniques. Other technologies such as chemical precipitation of the cyanide complex may be required.

The presence of other oxidizable materials affect the performance of the treatment system. Free cyanide is not the only constituent of wastewater than can be oxidized by chlorine-containing compounds or ozone. Organic materials (such as oils and surfactants) and reduced forms of metals (such as trivalent chromium and ferrous iron) will also react with the oxidizing agents. Consequently, enough oxidizing agent must be added to overcome the demand of both the free cyanide and the other materials.

d. *Design and Operating Variables Affecting Performance.* Four design and operating variables that the Agency monitors, to the extent possible, for effect on performance are:

- pH;
- Oxidizing agent feed quantity;
- Reaction time; and
- Type of oxidizing agent used.

We believe that evaluation of these parameters best provides a reasonable measure of assurance that the system is designed and operated properly.

(i) The pH must be kept in the alkaline range (above 7) in order to ensure that free cyanide is not released as toxic hydrogen cyanide gas to the atmosphere. Also, the pH for each process step must be controlled for the reaction to proceed at a reaction rate sufficient to prevent liberation of toxic cyanogen chloride gas. Additionally, if ORP controls are used to control feed of the oxidizing agent (discussed below), pH control must be very rigorous because the ORP value varies with changes in the pH value.

(ii) The feed quantity of the oxidizing agent (e.g. chlorine and ozone) affects performance. Enough oxidizing agent must be added to react fully with the free cyanide present. For batch systems, the oxidizing agent may be added until chemical analysis shows that no cyanide is detectable. Although detection levels may change somewhat, depending on the composition of the waste, it is generally possible to achieve a detection level of 10 ug/l in the treated waste.[1] For continuous systems, the

level of oxidizing agent should be monitored and controlled with an ORP meter. As noted earlier, ORP is sensitive to pH and, therefore, pH must be kept constant during the treatment process.

(iii) Reaction time should be sufficient to ensure that the cyanide destruction reactions have gone to completion. For continuous systems, reaction time is monitored by obtaining data on the flowrate of the waste. If the flowrate is at or below the design value for the volume of the system, and the initial concentration is at or below the design value, then the reaction time would be adequate.

(iv) Each of the oxidizing agents discussed (those containing chlorine and ozone) will work effectively. Consequently, the decision of which to use is usually based on economics and availability. However, different doses of each will be required. Also, for some oxidizing agents, such as ozone, smaller quantities of chemicals (lime or caustic soda) will be required to adjust pH.

5. High Temperature Metals Recovery

a. *Description and Applicability.* The high temperature metal recovery process separates metals from wastes by vaporizing the metals and collecting them. The Waelz kiln method is currently being used on steelmaking electric furnace air pollution control dust (K061). The process may also be applied to certain sludges containing high concentrations of metals.

b. *Basic Principles of Operation.* The metallic wastes that are fed into the kiln are normally in the form of an oxide. Heat is supplied to reduce the oxides to the metallic form and to vaporize the metals. This is not a destructive process, but a conversion to yield a reusable metal product. The Waelz kiln process consists of three steps: (1) the reduction of a metallic oxide, (2) the vaporization of metals, and (3) the recovery of a product. The first two steps are carried out in a kiln where high temperatures and excess carbon reduce the oxides to their metallic form. The primary reaction can be described as:

$MO + C M + CO$

where M = metal
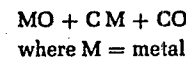
Once in their metallic form, the more volatile metals leave the kiln in the air stream where they are reoxidized as particulates and collected in a baghouse. The residual material, stripped of the more volatile metals, is quenched and collected. Both residuals and baghouse

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[1] The classical method for cyanide analysis (Method 9010 in EPA Publication SW–846) will detect both free cyanide and cyanide complexes with the exception of the cobalt-cyanide complex. Cyanate is not detected by this method. Cyanate will not form volatile hydrogen cyanide under the distillation procedures and it will not respond to the colorimetric procedure normally used to detect cyanide.

dust may have potential value as products.

c. *Waste Characteristics Affecting Performance.* The recovery of metals from wastes using high temperature processes is dependent on the initial concentration of certain metals and the presence of impurities. These waste characteristics determine whether the process can yield a reusable metal product.

If the initial concentration of recoverable metals in the waste is low, then the purity of the product may also be low. The ability to concentrate a specific metal from a waste to an enriched product is limited when other metals are present. Depending on the concentration of metals to be recovered relative to the concentration of other constituents, the product may not be suitable for reuse.

If the waste contains many metals with similar volatilities, then the product will contain a mixture of these metals. This product may not be reusable if the metals present are incompatible to the reuse. The removal or separation of impurities may not be possible, especially at low concentrations where they may be fixed into a matrix. Operation at higher temperatures may break these bonds, but this could lead to the presence of greater amounts of impurities in the product.

d. *Design and Operating Parameters Affecting Performance.* For the high temperature recovery of metals, the important design and operating parameters are the temperature in the kiln and the residence time.

The reduction of various metallic oxides and the volatilization of the metals occur at different temperatures. An increase in temperature will improve the removal of some constituents, but less volatile metals could also be liberated from the waste if they are present. The exact operating temperature is directly dependent upon the metals present in the waste and the metals being recovered.

The residence time of the material in the kiln also impacts the removal of metals from the waste. Adequate time must be provided for the reduction and volatization of the metals to allow maximum recovery. Due to the temperature dependency of the reactions, the residence time must also be optimized for the waste being fed to the kiln. The residence time is dependent upon the dimensions of the kiln and can be adjusted by varying the rate of rotation and the feed rate.

6. Filtration

a. *Description and Applicability.* Filtration is the operation in which a heterogeneous mixture of fluids and particles are separated by a filter medium that permits the flow of the fluid through the medium, but retains the particles.

Treatment of wastewater for removal of solid particles can be accomplished using either "in-depth" filtration (particles are trapped within the filter medium) or "cake-formation" filtration (filtered solids are stopped at the surface of the medium and buildup on one another to form a cake of increasing thickness). Typically, wastewaters with low concentrations of solid particles (generally below 1,000 ppm) employ in-depth filtration. Wastewaters or sludges with high concentrations of solid particles employ cake-formation filtration. This is commonly known as sludge dewatering. Sludge dewatering is described separately in Section V(B)(7).

In-depth filtration is used to process wastewaters containing relatively low concentrations of solids. Multimedia filtration, pressure or gravity sand filtration, and cartridge filtration are some of the types of equipment used for in-depth filtration. In-depth filtration is typically used as a polishing step for the supernatant after precipitation and settling (clarification) of wastewaters containing metal hydroxide precipitates.

b. *Basic Principals of Operations.* For in-depth filtration, the liquid to be filtered may flow by gravity or under pressure to the filter. For relatively large volume flows granulated media (such as sand or anthracite coal) are used to trap suspended solids within the pore spaces of the media. Wastewater is filtered until excessive pressure is required to maintain the flow or until the flow drops to an unacceptable level. Granular media in-depth filters are cleaned, after they are exhausted, by backwashing with filtered water that has been saved for that purpose. (Backwashing is always upflow to loosen the media granuals and resuspend the entrapped solids.) The backwash water, which may be as much as 10 percent of the volume of the filtered wastewater, is then returned to the treatment system, so that the solids in the backwash water can be settled in the system clarifier.

For relatively low flows, cartridge in-depth filtration can be used. In this case a cylindrically shaped filter media cartridge, such as a matted cloth, is placed within a sealed metal vessel. Wastewater is pumped through the cartridge until the flow drops excessively because of plugging of the media or until the pumping pressure becomes too high. The sealed vessel is then opened and the plugged cartridge removed and replaced with a new cartridge. The plugged cartridge is disposed.

In-depth filtration is capable of removing suspended solids in order to produce a filtrate (effluent) having only a few ppm suspended solids. Hence, if the suspended solids in the influent included insoluble metal hydroxides formed by chemical precipitation, then they could be removed to less than a few ppm.

c. *Waste Characteristics Affecting Performance.* The following characteristics of the waste will affect performance of an in-depth filter:

• Concentration of suspended material;

• Size of suspended particles; and

• Presence of grease and oils.

(i) Concentration—The higher the concentration of suspended solids in the wastewater to be filtered, the more quickly the filter will require backwashing (or removal of the cartridge). Hence, the size of the filter and/or the length of the filtering cycle will be affected.

(ii) Size of particles—Extremely small particles, in the collidal range, may not be filtered effectively in an in-depth filter and may appear in the filtrate (effluent). To mitigate against this problem, the wastewater clarification system should be modified prior to filtration by the use of appropriate coagulants, modified coagulant dosage, or different chemical precipitation techniques (for instance, lime neutralization usually produces larger particles than caustic soda precipitation).

(iii) Grease and oil—While grease and oils may be, in fact, effectively filtered, and while they may not reduce the effectiveness of filtering suspended solids, they may eventually coat filter media particles in granulated media filters, reducing the length of filter cycles by preventing effective backwashing. To the extent possible, grease and oil should be removed prior to filtration. If they cannot be removed, special backwashing techniques using detergents may be required.

d. *Design and Operating Variables that Affect Performance.* For in-depth filters, the following design and operating variables affect performance:

• Type of filter selected;

• Size of filter selected;

• Pressure of wastewater feed;

• Use of coagulants or filter aids, and

• Backwash technique.

(i) Type of filter—As noted earlier, the two main types of filters are granular media and cartridge. While they are both in-depth, cartridge depth is rarely more than an inch and is suited only to

low volume wastewaters and/or those with extremely low suspended solids. Usually, to develop the expected cycle time prior to cartridge disposal, several cartridges are placed in parallel. For granulated media filtration, a variety of media types and sizes are available. Also, some granulated media filters feed wastewater from the bottom up and others from the top down. (They are all backwashed from the bottom up.) Typically, when more than one media is used in the same filter (such as graded sand and anthracite coal), a greater capacity can be expected from a given size filter bed. Typically, upflow filtration will allow higher flowrates and trap more particles, but there is the danger of channelling (producing a "hole" in the filter bed through which unfiltered water will flow). The choice of type of filter is usually based on a combination of wastewater characteristics and economics.

(ii) Size of filter—Clearly, the larger the size of a filter, the more wastewater it will accommodate prior to back-washing or filter replacement. This affects performance only in that it may limit the hydraulic capacity of the entire treatment system.

(iii) Pressure of wastewater feed—Again, the higher the filtration pressure, the more rapidly filtration can take place. In any case, once design pressure is reached, the filter must be backwashed or the cartridges must be replaced, thus affecting cycle time and the overall hydraulic capacity of the treatment system.

(iv) Use of coagulants—Coagulants and filter aids can be added to the influent. Generally, these materials make very small particles larger and/or gelatinous particles less gelatinous. Filter runs can thus be lengthened and the clarity of the filtrate should be increased.

(v) Backwash techniques—Backwashing is applicable only to granular media filters, not to cartridge types. If backwash flows are too high, they may "fluidize" the media bed and wash away the filter media. If flow is too low, it may not expand the bed adequately and not remove all of the particles trapped in the filter media pores. In addition, if after a period of time backwashing becomes ineffective, the addition of detergents and surfactants to the backwash water may be necessary to clean the media bed of greases, oils, and other adherent materials.

7. Sludge Dewatering

a. *Description and Applicability.* This section presents a brief description of sludge dewatering, or cake-formation

filtration, that differentiates the technology from in-depth filtration which is presented Section V(B)(6). Cake-formation filtration is applied to sludges, typically those that have settled to the bottom of clarifiers, for additional dewatering. These sludges, which usually contain more than 10,000 ppm suspended solids, can be dewatered to 20 to 50 percent solids.

b. *Basic Principles of Operation.* For cake-formation filtration, settled sludge is either pumped through a cloth-type filter media (such as in a plate and frame filter that allows solid "cake" to build up on the media) or the sludge is drawn by vacuum through the cloth media (such as on a drum or vacuum filter, which also allows the solids to build). In both cases the solids themselves act as a filter for subsequent sludge solids. For a plate and frame type filter, when excessive pressure is required to force the sludge through the media, the filter is opened and the cake is removed for disposal or recovery (or additional treatment, if necessary). For the vacuum type filter, cake is removed continuously after as much water as possible has been drawn out of it. In both types of cake-formation filtration the liquid passing through the filter media is usually too high in suspended solids to be discharged to receiving streams, so it is returned to the treatment system. Also, for a specific sludge, the plate and frame type filter will usually produce a drier cake than a vacuum filter. Other types of cake-formation filters, such as belt filters, are also used for effective sludge dewatering.

c. *Waste Characteristics Affecting Performance.* The following characteristics of the waste will affect performance of a cake-formation type of filter:

• Concentration of suspended material;
• Size of particles; and
• Type of particles.

(i) Concentration—For plate and frame type filters, the more concentrated the inlet solids, the more rapidly cake will build up and the shorter the operating cycle will be. Consequently, these types of pressure filters should be sized accordingly. For vacuum filtration, a cake may not form at all if a minimum solids concentration does not exist in the influent. The higher the influent solids for a vacuum filter, the more firm and more dewatered will be the cake.

(ii) Size of particles—The smaller the particle size, the more the particles tend to go through the filter media. This is expecially true for a vacuum filter. Since the filtrate is usually returned to the treatment system, this tends not to be a

major concern unless significantly more particles to through the filter than are trapped on it. For a pressure filter (like a plate and frame), smaller particles may require higher pressures for equivalent throughput, since the smaller pore spaces between particles create resistance to flow.

(iii) Type of particles—Some solids formed during metal precipitation are gelatinous in nature and cannot be dewatered well by cake-formation filtration. In fact, for vacuum filtration a cake may not form at all. In most cases solids can be made less gelatinous by use of the appropriate coagulants and coagulant dosage prior to clarification, or after clarification but prior to filtration. In addition, the use of lime instead of caustic soda in metal precipitation will reduce the formations of gelatinous solids. Also the addition of filter aids to a gelatinous sludge, such as lime or diatomaceous earth, will help significantly. Finally, precoating the filter with diatomaceous earth prior to sludge filtration will assist in dewatering gelatinous sludges.

d. *Design and Operating Variables that Affect Performance.* For cake-formation filters, the following design and operating variables affect performance:

• Type of filter selected;
• Size of filter selected;
• Feed pressure (not applicable to vacuum filters); and
• Use of coagulants or filter aids.

(i) Type of filter—Typically, pressure type cake-formation filters (such as a plate and frame) will yield a drier cake than a vacuum type filter and will also be more tolerant of variations in influent sludge characteristics. Pressure type filters, however, are batch operations, so that when cake is built up to the maximum depth physically possible (constrained by filter geometry), or to the maximum design pressure, the filter is turned off while the cake is removed. A vacuum filter is a continuous device (i.e., cake discharges continuously), but will usually be much larger than a pressure filter with the same capacity. A hybrid device is a belt filter, which mechanically squeezes sludge between two continuous fabric belts.

(ii) Size of filter—As with in-depth filters, the larger the filter, the greater its hydraulic capacity and the longer the filter runs between cake discharge.

(iii) Feed pressure—For plate and frame filters, the higher the maximum pressure, the drier the cake, and the longer the runs prior to cake discharge. It must be noted, however, that for gelatinous solids, excessive pressures may cause the solids to compress in

such a way as to blind the filter and not allow additional sludge to be filtered. For vacuum filters, the maximum amount of vacuum applied is usually not very variable and is limited to about 20 to 25 inches of mercury. Hence, differential pressure is usually not a significant variable in vacuum filtration.

(iv) Use of coagulants—Coagulants and filter aids may be mixed with filter feed prior to filtration, as was the case with in-depth filters. However, their effect is much more dramatic with cake-formation filters, in that it may make the difference in a vacuum filter between no cake and a relatively dry cake. In a pressure filter, coagulants and filter aids will also significantly improve hydraulic capacity and cake dryness. Filter aids, such as diatomaceous earth, can be precoated on cake-formation filters (vacuum or pressure) for particularly difficult to filter sludges. The precoat layer acts somewhat like an in-depth filter in that sludge solids are trapped in the precoat pore spaces. Use of precoats and most coagulants or filter aids significantly increases the amount of sludge solids to be disposed of. However, polyelectrolyte coagulant usage usually does not increase sludge volume significantly because the dosage is low.

8. Ion Exchange

a. *Description and Applicability.* Ion exchange refers to a technology which removes positively charged ions (cations) or negatively charged ions (anions) from solutions and replaces them with other, more desirable, cations or anions.

The ion exchange treatment system consists of a column (or bed) filled with either cation exchange resin or anion exchange resin, through which the wastewater is pumped, usually on a continuous basis. Where it is desired to remove both cations and anions, the cation and anion exchangers are placed in series. (On some specialized systems, both cation and anion exchange resin are contained in the same column.) Additional equipment required are chemical feed systems and pumps used to regenerate the ion exchange columns when they have exhausted their capacity to remove ions.

Cation exchange is applicable to removal of all metal cations in relatively dilute solutions. (Typically, concentrated metal solutions will be pretreated first by chemical precipitation.) Anion exchange is applicable to removal of anionic forms of metals (e.g., chromates and metal complexes) in dilute solutions. It is important to note that a relatively small volume of concentrated wastewater is

produced when regenerating an ion exchanger. This concentrated waste stream may be treated for disposal by chemical precipitation and chrome reduction as applicable. If appropriate, it may also be recycled for metal recovery.

b. *Basic Principles of Operation.* An ion exchange resin consists of beads of natural or synthetic material to which either anions or cations are chemically bound. For instance, in a typical cation exchanger the ions are either sodium or hydrogen. When the resin is exposed to a solution containing ions of similar charge, the ions are exchanged for the ions in solution. For instance, if a nickel containing solution is pumped through a sodium-based cation exchanger, the nickel will be removed from solution and replaced with sodium. When the resin is exhausted, and the desired ions are no longer removed from solution (called "breakthrough"), the exchange resin is regenerated by passing a relatively low volume of a very concentrated (percent range) regenerant solution through the column. For instance, in the case of a sodium-based resin, a strong solution of sodium chloride is typically the regenerant solution. The regenerant solution forces the previously removed ions back into solution. This relatively low volume solution, now highly concentrated with the contaminants, must then be treated prior to disposal or for recovery of the cation or anion contaminants. The concentrated metal cations are usually treated by chemical precipitation. Chromates (anions) are reduced to trivalent chromium and then chemically precipitated. Trace cyanides (anions) or metal/cyanide anion complexes may be treated by cyanide oxidation.

c. *Waste Characteristics that Affect Performance.* The waste characteristics that affect performance of ion exchange systems are:

• the concentration and valence of the contaminant in the wastewater;

• The concentration and valence of other ions in the wastewater with the same charge as the contaminant (i.e., positive or negative);

• The amount of suspended solids in the wastewater; and

• The corrosiveness of the wastewater relative to the resin material.

(i) As the concentration and valence of adsorbable ions in the wastewater increases, the size of the resin bed required will increase, or alternatively, the bed will become exhausted more rapidly. This is because a given amount of ion exchange resin has only a specific number of sites at which it can adsorb charged ions. Hence, if the valence is doubled, the sites are used twice as

quickly. The same is true if the concentration is doubled.

(ii) Other ions in the wastewater with the same charge as the contaminant will compete for exchange sites on the resin. Hence, a low concentration of the contaminant of concern may be readily removed from a solution with low concentrations of other similarly charged ionic species, but the contaminant will not be removed as efficiently from solutions where high concentrations of similarly charged ions exist. Even if the ion of concern is removed effectively from a solution with high concentrations of similarly charged ions, the resin will become exhausted more rapidly, since it cannot differentiate between the contaminant and similarly charged ionic species.

(iii) Conventional ion exchange systems are downflow, i.e., the wastewater flows down through the resin bed. (Typically, regeneration is accomplished in the upflow mode.) Hence the bed will act as a filtering device. If excessive suspended solids, or grease and oils are contained in the wastewater the bed may clog and require backwashing prior to exhausting its exchange capacity. For some solids or oils backwashing may prove ineffective. Also, some ions tend to oxidize after being removed from solution. For instance Mn^{+2} (manganese) may oxidize to the Mn^{+4} form, which is insoluble. This may permanently foul the exchange sites, so that the resin will require premature replacement.

(iv) Some wastewaters are extremely corrosive to exchange resin materials. For instance strong, hot solutions of chromates will eventually oxidize many resins. Ion exchange capacity will decrease until replacement is required.

d. *Design and Operating Variables Affecting Performance.* The main design and operating parameter that affects the performance of ion exchange systems is the resin quality and quantity. Numerous cation and anion resins are commercially available. Different resins have different exchange capacities, and some have greater affinity than others for specific ions. Certain resins are designed to tolerate corrosive, oxidizing, or high temperature solutions, so that their exchange capacity does not degrade as rapidly with age. Most resins will effectively remove contaminant ions from solutions until they become exhausted. If, however, resin bed exhaustion occurs too frequently, or regeneration requires excessive volumes of regenerant, the type and/or quantity of resin might require changing. In some

instances, pretreatment technologies may be required prior to ion exchange.

When a resin bed is exhausted, this is referred to a "breakthrough", meaning that the ions which were to be removed from the wastewater are no longer being removed. Breakthrough may be detected in many ways. The most common method of detecting breakthrough for hydrogen ion based cation exchangers in series with hydroxyl based anion exchangers is to use an electrical conductivity meter. Before breakthrough, this type of system discharges deionized water, which has very low electrical conductivity. After breakthrough of either or both exchangers, acids, salts, or alkalies will be discharged. These have high conductivities. For hydrogen based cation exchangers or hydroxyl based anion exchangers operating independently (not in series with each other) breakthrough will be indicated by a change in pH, which is easily measured. Prior to breakthrough a hydrogen based cation exchanger discharges an acidic solution. A hydroxyl based anion exchanger discharges an alkaline solution. The pH change in the discharge will rapidly migrate to the pH of the raw waste. For sodium based cation exchangers and chloride based anion exchangers conductivity measurement is also effective in many cases, since the raw waste ions will have a different conductivity than the sodium and/or chloride ions.

The rate at which wastewater is fed to the ion exchanger has little effect on its effectiveness, since ions are adsorbed on the resins almost instantaneously, so long as exchange capacity exists. The limiting factor for the flow rate is the ability of the pump to pump a liquid through a packed resin bed.

C. Treatment Data Summary

This section presents the data reviewed by the Agency that support treatment of California List metals and cyanides to the EP regulatory levels or health-based prohibition levels. Included in this section are a summary of the Agency's available data and information on the treated concentrations of the constituents of concern, waste characteristics, and on design and operating parameters. This section also discusses the Agency's preliminary conclusions with regard to treatment of these wastes to levels equivalent to the EP regulatory level or health-based prohibition levels.

1. Arsenic

a. *Data Summary.* The Agency has three data points on the treatment of arsenic in wastewater from two facilities. These three data points have arsenic concentrations in the treated wastewater lower than the EP regulatory levels of 5.0 mg/l. Table 2 provides a summary of all available data on the treatment of arsenic in wastewater.

The Agency has 11 data points on the treatment of arsenic in waste *other than wastewater* from three facilities. Of the 11 data points, all 11 have arsenic concentrations in the leachate from the treated waste lower than the EP regulatory level of 5.0 mg/l. Table 3 provides a summary of all available data on the treatment of arsenic in waste other than wastewater.

b. *Data Analysis—Wastewater.* (i) Waste Characteristic Analysis. These three data points reflect treatment by chemical precipitation. The Agency has limited data on the range of waste characteristics pertinent to an evaluation of the performance of this technology. The only available waste characterization data that are important for an engineering analysis involve other metals concentrations.

The treatment data show a maximum influent concentration for arsenic of 160 mg/l, while the literature indicates untreated wastes may have concentrations as high as 430 mg/l. As stated previously in Section V(B)(1), high influent metal concentrations, per se, do not adversely affect treatment; however, high metal concentrations often indicate that the metals are complexed in solution and complexed metal compounds, if not dissociated, could have an adverse effect on treatment.

(ii) Design and Operating Parameters Analysis. For the three data points, the Agency has some design and operating data for two treatment points from one facility that document the operation of the treatment system.

(iii) Discussion. The Agency's best engineering judgment is that the EP regulatory level of 5.0 mg/l for arsenic can be met for the full range of California List wastewaters containing arsenic. In support of this position, the Agency points to the theoretical solubility limit of arsenic precipitates, chemical precipitation theory, and our knowledge of the technologies available to minimize the effects of constituents in the waste that can interfere with treatment performance. Additionally, the available data would not lead us to conclude otherwise.

The Agency recognizes the lack of data on the full range of waste characteristics and design and operating conditions that may affect treatment effectiveness. Therefore, we are

soliciting data that would aid the Agency in analyzing treatment performance for arsenic in wastewaters. The specific waste characterization data and design and operating data that the Agency needs are described in Section V(E), Request for Comments.

c. *Data Analysis—Waste Other Than Wastewater.* (i) Waste Characteristics Analysis. As stated above in the Data Summary, all 11 data points achieve the EP regulatory level. Each of these uses stabilization technology for treatment. Four of these data points represents bench-scale tests.

For these data points, the Agency has limited information on the range of waste characteristics pertinent to an evaluation of the performance of this technology. Most of the available waste characterization data that are important for an engineering analysis involve other metal concentrations.

The treatment data have a maximum total arsenic concentration of 12,000 mg/kg. The stabilization data for this data point represent bench-scale treatment.

(ii) Design and Operating Parameters Analysis. For the 11 data points, the Agency has limited design and operating data for four treatment points from two facilities. All of these data points represent bench-scale data.

(iii) Discussion. The Agency's best engineering judgment is that the EP regulatory level of 5.0 mg/l for arsenic can be met in leachate for the full range of California List waste other than wastewater. In support of this position, the Agency points to the facility's ability to change the ratio of stabilizing agents to waste quantities as needed to decrease mobility of the constituent; this assumes that an effective stabilizing agent and/or additives are available. Additionally, the curing conditions (e.g., length of cure and ambient conditions) can be controlled to ensure that the waste particles have had sufficient time to form a stable treated waste. Additionally, all the available data show that the EP regulatory level of 5.0 mg/l for arsenic can be achieved.

The Agency recognizes the lack of data on the full range of waste characteristics and design and operating conditions that may affect treatment effectivness. Therefore, we are soliciting data that would aid the Agency in analyzing treatment performance for arsenic in waste other than wastewater. The specific waste characteristic data and design and operating data that the Agency needs are described in Section V(E), Request for Comments.

TABLE 2.—ARSENIC CONCENTRATION DATA FOR WASTEWATER

Source [+]	Industry	Process generating waste	Treatment process	Waste codes [a]	Waste characterization data		Arsenic concentration data	
					Parameter	Concentration (mg/l)	Untreated Total (mg/l)	Treated Total (mg/l)
Bhattacharyya, et al. [1]	Nonferrous metal production.	NAV	Sulfide and lime precipitation.	NAV	Cadmium	3.5	160	1.8
					Lead	6.0		
					Mercury	0.9		
Bhattacharyya, et al. [2]	Nonferrous metal production.	NAV	Sulfide and lime precipitation.	NAV	Cadmium	14	125	1.9
					Lead	75		
					Mercury	0.8		
Nonferrous metals Dev. Doc.	Secondary lead production.	NAV	Hydroxide precipitation, filtration.	D004 D008	Lead	80	6.4	2.9

[+] See Section V(C)(10) for Data Sources.
[a] Waste code as reported in source.
NAV—Not available.

TABLE 3.—ARSENIC DATA FOR WASTE OTHER THAN WASTEWATER

Source [+]	Industry	Process generating waste	Treatment process	Waste codes	Waste characterization data		Arsenic Concentration data			
					Parameter	Concentration	Untreated Total (mg/kg)	Untreated EP-Tox (mg/l)	Treated Total (mg/kg)	Treated EP-Tox (mg/l)
192[b]	NAP	Synthetic waste.	Stabilizations.	NAP	Barium	12,000	NAV	NAV	0.135	
					Cadmium					
					Chromium					
					Lead					
					Mercury					
					Nickel					
					Silver					
					Selenium					
					6,600 mg/kg.					
					10,300 mg/kg.					
					10,900 mg/kg.					
					8,820 mg/kg.					
					11,300 mg/kg.					
					11,100 mg/kg.					
					3,900 mg/kg.					
					7,600 mg/kg.					
192[b]	NAP	Synthetic waste.	Stabilization.	NAP	Barium	3,680 mg/kg	6,400	NAV	NAV	0.139
					Cadmium	5,500 mg/kg				
					Chromium	6,300 mg/kg				
					Lead	3,5800 mg/kg				
					Mercury	600 mg/kg				
					Nickel	5,810 mg/kg				
					Silver	1,760 mg/kg				
					Selenium	4,600 mg/kg				
HAZCO[b]	NAP	Synthetic waste.	Stabilization.	NAP	Cadmium	1,090 mg/kg	2,267	NAV	2,195	<0.5
					Lead	1,872 mg/kg				
					Mercury	1,752 mg/kg				
					Selenium	599 mg/kg				
					Waste lube oil.	858,000 mg/kg.				
					Alcohol	55,000 mg/kg				
					Water	87,000 mg/kg				

TABLE 3.—ARSENIC DATA FOR WASTE OTHER THAN WASTEWATER—Continued

Source[+]	Industry	Process generating waste	Treatment process	Waste codes	Waste characterization data		Arsenic Concentration data			
							Untreated		Treated	
					Parameter	Concentration	Total (mg/kg)	EP-Tox (mg/l)	Total (mg/kg)	EP-Tox (mg/l)
192[b]	NAP	Synthetic waste.	Stabiliza-tion.	NAP	Barium	18 mg/kg	1,100	NAV	NAV	0.028
					Cadmium	2,400 mg/kg				
					Chromium	1,710 mg/kg				
					Lead	1,170 mg/kg				
					Mercury	1,060 mg/kg				
					Nickel	1,360 mg/kg				
					Silver	290 mg/kg				
					Selenium	750 mg/kg				
CBI	CBI	CBI	Stabiliza-tion.	NAV	CBI	CBI	350	NAV	NAV	0.19
CBI	CBI	CBI	Stabiliza-tion.	NAV	CBI	CBI	310	NAV	NAV	0.12
CBI	CBI	CBI	Stabiliza-tion.	NAV	CBI	CBI	287	NAV	NAV	0.48
CBI	CBI	CBI	Stabiliza-tion.	NAV	CBI	CBI	255	NAV	NAV	0.49
CBI	CBI	CBI	Stabiliza-tion.	NAV	CBI	CBI	144	NAV	NAV	0.15
CBI	CBI	CBI	Stabiliza-tion.	NAV	CBI	CBI	120	NAV	NAV	0.21
CBI	CBI	CBI	Stabiliza-tion.	NAV	CBI	CBI	110	NAV	NAV	0.21

[+]See Section V(C)(10) for Data Sources.
[b]Data represent bench-scale test.
CBI—Confidential Business Information.
NAV—Not applicable.
NAP—Not applicable.

2. Cadmium

a. *Data Summary.* The Agency has 16 data points on the treatment of cadmium in wastewaters from 12 facilities. Of the 16 data points, 15 are usable. One data point cannot be used because the laboratory analysis for the effluent was reported at a detection level greater than the EP regulatory level. Of the 15 data points, 13 have cadmium concentrations in the treated wastewater lower than the EP regulatory level of 1.0 mg/l. Chemical precipitation was the treatment technology used for 14 of the 15 data points; ion exchange was used to treat one waste stream. Table 4 provides a summary of all available data on treatment of cadmium in wastewater.

The Agency has 43 data points on the treatment of cadmium in waste *other than wastewater* from eight facilities. Of the 43 data points, 30 have cadmium concentrations in the leachate from the treated waste that are lower than the EP regulatory level of 1.0 mg/l. Table 5 provides a summary of all available data on cadmium in waste other than wastewater.

b. *Data Analysis—Wastewater.* (i) Waste Characteristic Analysis. Of the 13 points that achieve the EP regulatory level, 12 reflect trreatment by chemical

precipitation, the principal technology for treating cadmium in wastewaters. The Agency has limited data on the range of waste characteristics pertinent to an evaluation of the performance of this technology. Most of the available waste characterization data that are important for an engineering analysis involve other metal concentrations.

The treatment data have a maximum influent concentration for cadmium of 240 mg/l, while the literature indicated untreated wastes may have concentrations as high as 5,000 mg/l. As stated in Section V(B)(1), high influent concentrations, per se, do not adversely affect treatment; however, high metal concentrations often indicate that the metals are complexed in solution and complexed metal compounds, if not disassociated, could have an adverse effect on treatment.

(ii) Design and Operating Parameters Analysis. For the 12 data points that achieve the EP regulatory level, the Agency has some design and operating data for four treatment points from two facilities that document the operation of the facility.

(iii) Discussion. The Agency's best engineering judgment is that the EP regulatory level of 1.0 mg/l for cadmium can be met for the full range of

California List wastes containing cadmium. In support of this position, the Agency points to the theoretical solubility limit of cadmium precipitates, chemical precipitation theory, and our knowledge of the technologies available to minimize the effects of constituents in the waste that can interfere with treatment performance. Additionally, the available data would not lead us to conclude otherwise.

In the case of the data point that does not show achievement of the EP regulatory level, the Agency looked at the waste characteristics and treatment design and operation to determine why these values were not attained. Relative to waste characteristics, the waste exhibited high oil and grease and high total dissolved solid values. These parameters can adversely affect the effectiveness of the treatment. We expect that preliminary treatment, such as oil-water separation and/or emulsion breaking, can remedy any problems associated with high oil and grease content. Reducing the high TDS value can be accomplished using ion exchange, but can be a difficult problem to resolve. With regard to our analysis of the design and operation of the treatment system used, the Agency had no data to show that the treatment

system was designed and operated properly; therefore, we cannot conclude that the EP regulatory level is not attainable.

The Agency recognizes the lack of data on the full range of waste characteristics and design and operating conditions that may affect treatment effectiveness. Therefore, we are soliciting data that would aid the Agency in analyzing treatment performance for cadmium in wastewaters. A description of the specific waste characterization data and design and operating data that the Agency needs can be found in Section V(E), Request for Comments.

c. *Data Analysis—Waste Other than Wastewater.* (i) Waste Characteristics Analysis. As stated above in the data summary, 30 of the 43 data points achieve the EP regulatory level. Each of these uses stabilization technology for treatment.

Of the 30 data points that achieve the EP regulatory levels, the Agency has limited data on the range of waste characteristics pertinent to an evaluation of the performance of this technology. Most of the available waste characterization data that are important for an engineering analysis involve other metals and oil and grease concentrations. For the wastes where EP regulatory levels were achieved, the maximum total cadmium concentration was 31,200 mg/kg. The stabilization data for this data point represent bench scale treatment results.

(ii) Design and Operating Parameters Analysis. For the 30 data points that achieve the EP regulatory levels, the Agency has limited design and operating data for six treatment points from four facilities. Three of the data points represent bench scale experimental data.

(iii) Discussion. The Agency's best engineering judgment is that the EP regulatory level of 1.0 mg/l for cadmium can be met in leachate for the full range of California List waste other than wastewater. In support of this position, the Agency points to facility's ability to change the ratio of stabilizing agents to waste quantities as needed to decrease mobility of the constituent; this assumes that an effective stabilizing agent and/or additives are available. Additionally, the curing conditions (e.g., length of cure and ambient conditions) can be controlled to ensure that the waste particles have had sufficient time to form a stable treated waste. Additionally, the Agency's evaluation of the available data would not lead us to conclude otherwise.

In the cases where the treated waste leachate did not achieve the EP regulatory level, the Agency looked at the waste characteristics and treatment design and operation to determine why these values were not attained. Relative to waste characteristics, one of the 13 data points had untreated waste with a high oil and grease content that could have had an adverse affect on the performance of the stabilization

technology. Oil and grease can be removed by emulsion breaking or separation in a pretreatment step. For another of the data points that do not achieve the EP regulatory level, the initial concentration is three times the next highest concentration that achieves the EP regulatory levels (98,000 mg/kg vs. 31,200 mg/kg). However, the leachate concentration for this data point is so much higher than for the other data point (98 mg/l vs. <0.01 mg/l) that we believe that stabilization process is not properly designed. EPA has no other waste characteristic data on these data points or other data points, to determine why the EP regulatory levels were not achieved. Relative to analysis of the design and operation of the treatment systems used, the Agency had no data to determine whether poor design or operation contributed to the failure of the systems to achieve the EP regulatory levels.

The Agency recognizes that we lack data on the full range of waste characteristics and design and operating conditions that may affect treatment effectiveness. Therefore, we are soliciting information to aid the Agency in analyzing treatment performance for cadmium in wastes other than wastewater. The specific waste characteristics data and design and operating data that the Agency needs are described in Section V(E), Request for Comments.

TABLE 4.—CADMIUM DATA FOR WASTEWATER

Source[+]	Industry	Process generating waste	Treatment process	Waste codes[a]	Waste characterization data		Cadmium concentration data	
					Parameter	Concentration (mg/l)	Untreated Total (mg/l)	Treated Total (mg/l)
Battery manufacturing dev. doc.	Lead battery manufacturing.	NAV	Ferrite co-precipitation.	NAV	Lead................ Mercury............ Nickel...............	475............... 7.4................. 1,000..............	240	0.008
Frontier Chemical Company.	Batter manufacture.	NAV	Lime precipitation, filtration, carbon adsorption.	D002 D007	Lead................ TOC................ Oil & grease...... TSS................ TDS................ Nickel...............	1.1–3.8.............. 5600–19000........ 2600–18000........ 2400–60000........ 10000–170000.... 4.3–500............	3.9–180	0.15–1.4
Chem Pro Inc............	NAV..................	NAV	Chemical precipitation.	NAV	Oil & grease......	150 mg/kg.	88	0.7
Envirite [4]...............	TSDF..................	NAV	Chemical precipitation, filtration.	F006 K062 D003	Chromium.......... Copper............. Lead................ Zinc................ Nickel............... Oil & grease......	617................. 137................. 136................. 135................. 382................. 322.................	23	<5
Bhattacharyya, et al. [2].	Nonferrous metal production.	NAV	Sulfide and lime precipitation.	NAV	Arsenic............. Lead................ Mercury............	125................. 75................. 0.8.................	14	<0.01

TABLE 4.—CADMIUM DATA FOR WASTEWATER—Continued

Source+	Industry	Process generating waste	Treatment process	Waste codes[a]	Waste characterization data		Cadmium concentration data	
					Parameter	Concentration (mg/l)	Untreated Total (mg/l)	Treated Total (mg/l)
Envirite [1]	TSDF	NAV	Chemical precipitation, filtration.	F006 K062 D003 D002	Zinc Hex. Chrom. Chromium Copper Lead Nickel Oil & grease	116 893 2581 138 64 471 28.4	13	<0.15
Envirite [2]	TSDF	NAV	Chemical precipitation, filtration.	F006 K062 D003 D002	Nickel Hex. Chrom. Chromium Copper Lead Oil & grease	470 807 2279 133 54 54	10	<0.5
Envirite [3]	TSDF	NAV	Chemical precipitation, filtration.	F006 K062	D003 D002 Lead Hex. Chrom. Chromium Copper Nickel Zinc Oil & grease	Lead Hex. Chrom. 769 2314 72 426 171 113	108	10
Nonferrous metals, dev. doc.	Secondary lead production.	NAV	Hydroxide precipitation, filtration.	D004 D008	Lead	80	6.4	2.9
Battery manufacturing dev. doc.	Lead battery manufacturing.	NAV	Ion exchange	NAV	Hex. chrom. Cyanide Nickel	7.1 9.8 6.2	5.7	<0.01
Battery manufacturing dev. doc.	Lead battery manufacturing.	NAV	Hydroxide precipitation, sedimentation.	NAV	NAV	NAV	3.8	0.08
Bhattacharyya, et al. [1].	Nonferrous metal production.	NAV	Sulfide and lime precipitation.	NAV	Arsenic Lead Mercury	160 6.0 0.9	3.5	<0.02
Battery manufacturing dev. doc.	Lead battery manufacturing.	NAV	Hydroxide precipitation.	NAV	NAV	NAV	2.8	0.055
Batter manufacturing dev. doc.	Zinc battery manufacturing.	NAV	Lime precipitation, settling, filtration.	NAV	Mercury Nickel	100 1100	2.04	0.067
Metal finishing dev. doc.	Metal finishing	NAV	Chemical precipitation, sedimentation.	NAV	NAV	NAV	1.88	0.018
Metal finishing dev. doc.	Metal finishing	NAV	Chemical precipitation, sedimentation.	NAV	NAV	NAV	1.0	0.015

+ See section V(C)(10) for Data Source.
[a] Waste codes as reported in source.
NAV—Not available.

TABLE 5.—CADMIUM DATA FOR WASTE OTHER THAN WASTEWATER

Source [1]	Industry	Process generating waste	Treatment process	Waste codes [2]	Waste characterization data		Cadmium concentration data			
					parameter	concentration	Untreated		Treated	
							Total (mg/kg)	EP-Tox (mg/l)	Total (mg/kg)	EP-Tox (mg/l)
CBI	CBI	CBI	Stabilization.	NAV [5]	CBI [7]	CBI	98000	[4] NAV	NAV	98
UNH [3]	NAP	Synthetic waste.	Stabilization.	NAP [6]	NAV	NAV	[4] 31200	NAV	NAV	<0.01

TABLE 5.—CADMIUM DATA FOR WASTE OTHER THAN WASTEWATER—Continued

Source [1]	Industry	Process generating waste	Treatment process	Waste codes [2]	Waste characterization data		Cadmium concentration data			
							Untreated		Treated	
					parameter	concentration	Total (mg/kg)	EP-Tox (mg/l)	Total (mg/kg)	EP-Tox (mg/l)
UNH [3]	NAP	Synthetic waste.	Stabilization.	NAP	NAV	NAV	[4] 15600	NAV	NAV	<0.01
192 [3]	NAP	Synthetic waste.	Stabilization.	NAP	Barium Chromium Lead Mercury Nickel Silver Arsenic Selenium	6600 mg/kg	10900 mg/ kg 8820 mg/ kg 11300 mg/ kg 11100 mg/ kg 3900 mg/ kg 12000 mg/ kg 7600 mg/ kg	10300	NAV	NAV
CBI	CBI	CBI	Stabilization.	NAV	CBI	CBI	9900	NAV	NAV	9.39
CBI	CBI	CBI	Stabilization.	NAV	CBI	CBI	9900	NAV	NAV	41.6
CBI	CBI	CBI	Stabilization.	NAV	CBI	CBI	7104	NAV	NAV	0.037
192 [3]	NAP	Synthetic waste.	Stabilization.	NAP	Barium Chromium Lead Mercury Nickel Silver Arsenic Selenium	3680 mg/kg 6300 mg/kg 3580 mg/kg 600 mg/kg 5810 mg/kg 1760 mg/kg 6400 mg/kg 4600 mg/kg	5500	NAV	NAV	8.7
CBI	CBI	CBI	Stabilization.	NAV	CBI	CBI	4100	NAV	NAV	49.0
CBI	CBI	CBI	Stabilization.	NAV	CBI	CBI	3940	NAV	NAV	6.84
UNH [3]	NAP	Synthetic waste.	Stabilization.	NAP	NAV	NAV	[4] 3120	NAV	NAV	<0.01
192 [3]	NAP	Synthetic waste.	Stabilization.	NAP	Barium Chromium Lead Mercury Nickel Silver Arsenic Selenium	18 mg/kg 1710 mg/kg 1170 mg/kg 1060 mg/kg 1360 mg/kg 290 mg/kg 1100 mg/kg 750 mg/kg	2400	NAV	NAV	3.3
CBI	CBI	CBI	Stabilization.	NAV	CBI	CBI	1210	NAV	NAV	0.02
HAZCO [3]	NAP	Synthetic waste.	Stabilization.	NAP	Arsenic Lead Mercury Seleium Waste lube oil. Alcohol Water	2267 mg/kg 1872 mg/kg 1752 mg/kg 599 mg/kg 858000 mg/ kg. 55000 mg/kg 87000 mg/kg	1090	NAV	10563.1	
CBI	CBI	CBI	Stabilization.	NAV	CBI	CBI	617	NAV	NAV	1.05

617	EAF steel production.	EAF steel production.	Stabilization.	K061	Lead Nickel TOC Oil & greese	38000 ppm 200 ppm 0.03-0.04% 0.04-0.06%	600	NAV	NAV	0.02-0.03
688	EAF steel production.	EAF steel production.	Stabilization.	K061	Lead Oil & greese TOC	33618 mg/kg. 18-127 102-168 mg/kg.	537-591	NAV	217-265.	0.03-0.04
CBI	CBI	CBI	Stabilization.	NAV	CBI	CBI	524	NAV	NAV	0.03
192	TSDF	NAV	Lime neutralization,. Chemical fixation,. Stabilization.	K062 D002	Lead Nickel pH	0.12-204 mg/kg. 30-124.8 mg/kg. <1-7.0	[8] 0.11-310	NAV	[8] 6.0	0.02-0.03
CBI	CBI	CBI	Stabilization.	NAV	CBI	CBI	286	NAV	NAV	0.49
CBI	CBI	CBI	Stabilization.	NAV	CBI	CBI	241	NAV	NAV	4.19
CBI	CBI	CBI	Stabilization.	NAV	CBI	CBI	211.0	NAV	NAV	0.29
681	EAF steel production.	EAF steel production.	Stabilization.	K061	Arsenic Lead Selenium	50mg/kg. 15000 mg/kg. 70 mg/kg	200	1.4	<200	<0.02-0.02
CBI	CBI	CBI	Stabilization.	NAV	CBI	CBI	160.4	NAV	NAV	0.042
CBI	CBI	CBI	Stabilization.	NAV	CBI	CBI	100	NAV	NAV	3.35
CBI	CBI	CBI	Stabilization.	NAV	CBI	CBI	88.1	NAV	NAV	0.035
CBI	CBI	CBI	Stabilization.	NAV	CBI	CBI	84	NAV	NAV	0.08
CBI	CBI	CBI	Stabilization.	NAV	CBI	CBI	80	NAV	NAV	1.14
CBI	CBI	CBI	Stabilization.	NAV	CBI	CBI	77	NAV	NAV	0.02
CBI	CBI	CBI	Stabilization.	NAV	CBI	CBI	54.1	NAV	NAV	0.052
CBI	CBI	CBI	Stabilization.	NAV	CBI	CBI	49	NAV	NAV	0.11
CBI	CBI	CBI	Stabilization.	NAV	CBI	CBI	38.1	NAV	NAV	0.051
CBI	CBI	CBI	Stabilization.	NAV	CBI	CBI	38	NAV	NAV	0.06
CBI	CBI	CBI	Stabilization.	NAV	CBI	CBI	38	NAV	NAV	0.16
CBI	CBI	CBI	Stabilization.	NAV	CBI	CBI	36.5	NAV	NAV	0.029
CBI	CBI	CBI	Stabilization.	NAV	CBI	CBI	35.6	NAV	NAV	0.137
CBI	CBI	CBI	Stabilization.	NAV	CBI	CBI	34	NAV	NAV	0.04
CBI	CBI	CBI	Stabilization.	NAV	CBI	CBI	33.1	NAV	NAV	0.024
CBI	CBI	CBI	Stabilization.	NAV	CBI	CBI	27.4	NAV	NAV	0.025
CBI	CBI	CBI	Stabilization.	NAV	CBI	CBI	27	NAV	NAV	0.035
CBI	CBI	CBI	Stabilization.	NAV	CBI	CBI	24.3	NAV	NAV	0.028
CBI	CBI	CBI	Stabilization.	NAV	CBI	CBI	21	NAV	NAV	0.3
CBI	CBI	CBI	Stabilization.	NAV	CBI	CBI	20.6	NAV	NAV	0.017

[1] See section V(C)(10 for Data Sources
[2] Waste codes as reported in source.
[3] Data represent bench-scale test.
[4] Cadmium concentration in sludge given in test as mg/l. Converted to mg/kg assuming typical sludge density of about 100 lb/ft [3].
[5] NAV—Not available.
[6] NAP—Not applicable.
[7] CBI—Confidential business information.
[8] mg/l

3. Hexavalent Chromium

a. *Data Summary.* The Agency has seven data points on the treatment of hexavalent chromium in wastewater from four facilities. Of the seven data points, all have hexavalent chromium concentrations in the treated wastewater lower than the EP regulatory level of 5.0 mg/l. Table 6 provides a summary of all available data for the treatment of hexavalent chromium in wastewater.

Chemical reduction was the treatment technology used for six of the data points. Ion exchange was applied in the case of the other data point.

The Agency has seven data points for the treatment of hexavalent chromium in waste *other than wastewater* from two facilities. Stabilization was identified as the treatment technology for all of the data points. Of the seven data points, two have hexavalent chromium concentrations in the leachate from the treated waste that are lower than the EP regulatory level of 5.0 mg/l. Table 7 provides a summary of all available data on the treatment of hexavalent chromium in waste other than wastewater.

b. *Data Analysis—Wastewater.* (i) Waste Characteristic Analysis. Of the seven points, six reflect treatment by chemical reduction. The Agency has limited data on the range of waste characteristics pertinent to an evaluation of the performance of this technology. Most of the available waste characterization data that are important for an engineering analysis involve other reducible compounds (mainly metals) in the waste.

The treatment data have a maximum influent concentration for hexavalent

chromium of 1,230 mg/l, while the literature indicates untreated wastes may have concentrations as high as 270,000 mg/l. The Agency believes that high hexavalent chromium concentrations, per se, do not adversely affect treatment by hexavalent chromium reduction. Proper adjustment of the reagent dose and sufficient residence time to allow the reaction to go to completion should provide adequate treatment for the range of untreated waste concentrations that the Agency would expect.

(ii) Design and Operating Parameters Analysis. For the seven data points, the Agency has some design and operating data for four treatment points from one facility that can be used to document the operation of the facility.

(iii) Discussion. The Agency's best engineering judgment is that the EP regulatory level of 5.0 mg/l for hexavalent chromium can be met for the full range of California List wastewaters containing hexavalent chromium. In support of this position, the Agency points to chemical reduction theory and our knowledge of the technologies available to minimize the effects of constituents in the waste that can interfere with treatment performance. Additionally, the available data would not lead us to conclude otherwise.

The Agency recognizes that we lack data on the full range of waste characteristics and design and operation conditions that may affect treatment effectiveness. Therefore, we are soliciting information to aid the Agency in analyzing treatment performance for hexavalent chromium in wastewater. The specific waste characterization data and design and operating data that the

Agency needs are described in Section V(E), Request for Comments.

c. *Data Analysis—Waste Other than Wastewater.* (i) Waste Characteristic Analysis. As stated above in the data summary, only two of the seven available data points achieve the EP regulatory level for hexavalent chromium. Each of these uses stabilization technology for treatment. The treatment data have a maximum influent concentration for hexavalent chromium of 709,970 mg/kg.

The Agency has no waste characteristics data pertaining to the performance of stabilization for the data reported in Table 7.

(ii) Design and Operating Parameters Analysis. Of the seven data points, the Agency has design and operating data for six of the treatment points to document the operation of the bench scale tests. The design and operating data cover all parameters of the stabilization treatment process that the Agency believes to be significant. However, information was not provided as to the basis of the design conditions and, therefore, it is not possible to determine if the system was optimized.

(iii) Discussion. While data are limited, the concentration of hexavalent chromium in the leachate tended to increase as the concentration in the waste increased. The Agency believes that the performance of stabilization on wastes containing hexavalent chromium is adversely affected by the high solubility of hexavalent chromium compounds, and that treatment of these wastes by hexavalent chromium reduction is the recommended alternative. EP regulatory levels can be attained after the application of chemical reduction technology.

TABLE 6. HEXAVALENT CHROMIUM DATA FOR WASTEWATER

Source [+]	Industry	Process generating waste	Treatment process	Waste codes [a]	Waste characterization data		Hexavalent chromium concentration data	
					Parameter	Concentration (mg/l)	Untreated	Treated
							Total (mg/l)	Total (mg/l)
Envirite [1]	TSDF	NAV	Chemical reduction	F006 K062 D003 D002	Cadmium Nickel Chromium Copper Lead	10 470 2279 133 54	1230	0.19
Envirite [2]	TSDF	NAV	Chemical reduction	F006 K062 D003 D002	Cadmium Chromium Copper Lead Nickel Zinc	10 2314 72 108 426 171	1180	0.121

TABLE 6. HEXAVALENT CHROMIUM DATA FOR WASTEWATER—Continued

Source [*]	Industry	Process generating waste	Treatment process	Waste codes [a]	Waste characterization data		Hexavalent chromium concentration data	
					Parameter	Concentration (mg/l)	Untreated Total (mg/l)	Treated Total (mg/l)
Envirite [3]	TSDF	NAV	Chemical reduction	F006 K062 D003 D002	Cadmium Zinc Chromium Copper Lead Nickel Zinc	13 116 2581 138 64 471 116	1100	0.011
Envirite [4]	TSDF	NAV	Chemical reduction	F006 K062 D003	Zinc Nickel Chromium Copper Lead	71 1414 2236 91 18	1070	0.058
Battery manufacturing.	Lead battery manufacturing.	NAV	Chemical reduction	NAV	NAV	NAV	25.6	<0.014
Battery manufacturing.	Lead battery manufacturing.	NAV	Chemical reduction	NAV	NAV	NAV	11.45	<0.005
Battery manufacturing.	Lead battery manufacturing.	NAV	Ion exchange	NAV	Cadmium Cyanide Nickel	5.7 9.8 6.2	7.1	0.01

[*] See Section V(C)(10) for Data Sources.
[a] Waste codes as reported in source.
NAV—Not available.

TABLE 7. HEXAVALENT CHROMIUM DATA FOR WASTE OTHER THAN WASTEWATER

Source [*]	Industry	Process generating waste	Treatment process	Waste codes	Waste characterization data		Hexavalent chromium concentration data			
					Parameter	Concentration	Untreated	Treated		
								Total EP-Tox (mg/kg) (mg/l)	Total (mg/kg)	EP-Tox (mg/l)
CBI	CBI	CBI	Stabilization	NAV	CBI	CBI	709,970	NAV	NAV	100
UNH [b] [1]	NAP	Synthetic waste.	Stabilization	NAP	NAV	NAV	45,000	NAV	NAV	56.3
UNH [b] [2]	NAP	Synthetic waste.	Stabilization	NAP	NAV	NAV	45,000	NAV	NAV	158.5
UNH [b] [3]	NAP	Synthetic waste.	Stabilization	NAP	NAV	NAV	23,900	NAV	NAV	13.5
UNH [b] [4]	NAP	Synthetic waste.	Stabilization	NAP	NAV	NAV	23,900	NAV	NAV	60.7
UNH [b] [5]	NAP	Synthetic waste.	Stabilization	NAP	NAV	NAV	4,950	NAV	NAV	1.3
UNH [b] [6]	NAP	Synthetic waste.	Stabilization	NAP	NAV	NAV	4,950	NAV	NAV	4.5

[*] See Section V(C)(10) for Data Sources.
[b] These data represent bench-scale test.
NAV—Not available.
NAP—Not available.
CBI—Confidential Business Information.

4. Lead

a. *Data Summary.* The Agency has 16 data points on the treatment of lead in wastewater from ten facilities. Of the 16 data points, 15 have lead concentrations in the treated wastewater lower than the EP regulatory level of 5.0 mg/1. Of the 15 points that achieve the EP regulatory level, all reflect treatment by chemical precipitation. Table 8 provides a summary of all available data for the treatment of lead in wastewaters.

The Agency has 94 data points on the treatment of lead in waste *other than wastewater* from nine facilities. Of the 94 data points, 90 have lead concentrations in the leachate from the treated waste lower than the EP regulatory level of 5.0 mg/1. Of the 90 points that achieve the EP regulatory level, all reflect treatment by

stabilization. Table 9 provides a summary of all available data on lead in waste *other than wastewater.*

b. *Data Analysis—Wastewater.* (i) Waste Characteristic Analysis. Of the 15 data points that achieve the EP regulatory level, all reflect treatment by chemical precipitation, the principal technology for treating lead in wastewaters. The Agency has limited data on the range of waste characteristics pertinent to an evaluation of the performance of this technology. Most of the available waste characterization data that are important for an engineering analysis involve other metal concentrations.

For the one data point where the EP regulatory level was not achieved, the influent level was 1,900 mg/1. As stated previously in Section V(B)(1), high influent concentrations, per se, do not adversely affect treatment; however, high influent metal concentrations often are an indication that the metals are complexed in solution and complexed metal compounds, if not dissociated, could have an adverse effect on treatment.

(ii) Design and Operating Parameter Analysis. For the 15 data points that achieve the EP regulatory level, the Agency has some design and operating data for six treatment points from one facility that document the operation of the facility.

(iii) Discussion. The Agency's best engineering judgment is that the EP regulatory level of 5.0 mg/1 for lead can be met for the full range of California List wastewaters containing lead. In support of this position, the Agency points to theoretical solubility limit of lead precipitates, chemical precipitation theory, and our knowledge of the technologies available to minimize the effects of constituents in the waste that can interfere with treatment performance. In addition, the available data does not lead us to another conclusion.

In the case of the one data point that does not show achievement of the EP regulatory level, there are no additional waste characterization data to indicate why the EP regulatory level was not met. With regard to our analysis of the design and operation of the treatment system used, the Agency had no data to show that the treatment system was designed and operated properly.

The Agency recognizes the lack of data on the full range of waste characteristics and design and operating conditions that may affect treatment effectiveness. Therefore, we are soliciting data that would aid the Agency in analyzing treatment performance for lead in wastewaters. A description of the specific waste characterization data and design and operating data that the Agency needs can be found in Section V(E), Request for Comments.

c. *Data Analysis—Waste Other than Wastewater.* (i) Waste Characterization Analysis. As stated above in the data summary, 90 of the 94 data points show that the EP regulatory level for lead can be achieved. Of the 90 points that achieve the EP regulatory level, all reflect treatment by stabilization. The Agency has limited information on the range of waste characteristics pertinent to an evaluation of the performance of this technology. Most of the available waste characterization data that are important for an engineering analysis involve other metal concentrations.

For the wastes that were stabilized so that the leachate met the EP regulatory level, the highest concentration of lead was 57,000 mg/kg.

(ii) Design and Operating Parameter Analysis. For the 90 data points that achieve the EP regulatory level, the Agency has some design and operating data for four treatment points at four facilities that generally describe the stabilizing agent and ratio of waste to stabilizing agent.

(iii) Discussion. The Agency's best engineering judgment is that the EP regulatory level of 5.0 mg/1 for lead can be met in leachate for the full range of California List waste other than wastewater. In support of this position, the Agency points to the facility's ability to change the ratio of stabilizing agents to waste quantities as needed to decrease mobility of the constituent; this assumes that an effective stabilizing agent and/or additives are available. Additionally, the curing conditions (e.g., length of cure and ambient conditions) can be controlled to ensure that the waste particles have had sufficient time to form a stable treated waste. Additionally, the Agency's evaluation of the available data would not lead us to conclude otherwise.

For the four values that do not achieve the EP regulatory level of 5.0 mg/1, only two of them have waste concentrations higher than wastes which we show to achieve the EP regulatory level (96,200 mg/kg, EP of 938 mg/1; 63,150 mg/kg, EP of 22.8 mg/1). For the first point, the very high leachate value (938 mg/1) indicates that the stabilization process was not well-designed. In the case of the second point, the untreated concentration (63,150 mg/kg) is approximately the same as the concentration in a different waste (57,000 mg/kg) that does achieve the EP regulatory level. The Agency has no other waste characterization data on any of the four values that do not achieve the EP regulatory level that would have us conclude the EP regulatory level cannot be achieved. Additionally, we do not have any design and operating data that show the stabilization processes for the four values that do not achieve the EP regulatory level are well-designed and operated.

The Agency recognizes that we lack data on the full range of waste characteristics and design and operating conditions that may affect treatment effectiveness. Therefore, we are soliciting information to aid the Agency in analyzing treatment performance for lead in wastes other than wastewater. The specific waste characteristics data and design and operating data that the Agency needs are described in Section V(E), Request for Comments.

TABLE 8—LEAD DATA FOR WASTEWATER

Source[+]	Industry	Process generating waste	Treatment process	Waste codes[a]	Waste characterization data		Lead concentration data	
					Parameter	concentration (mg/l)	Untreated Total (mg/l)	Treated Total (mg/l)
EWE	Electronic & plating.	NAV	Chemical precipitation.	NAV	Oil & grease.........	150 mg/kg	1900	92

TABLE 8—LEAD DATA FOR WASTEWATER—Continued

Source[+]	Industry	Process generating waste	Treatment process	Waste codes[a]	Waste characterization data		Lead concentration data	
					Parameter	concentration (mg/l)	Untreated Total (mg/l)	Treated Total (mg/l)
Battery manufacturing.	Lead battery manufacturing.	NAV	Ferrite co-precipitation.	NAV	Cadmium	240	475	0.01
					Mercury	7.4		
					Nickel	1000		
Envirite [2]	TSDF	NAV	Chemical precipitation Filtration.	F006 D003 K062	Zinc	151	212	>0.01
					Hex. Chrom	0.13		
					Chromium	831		
					Copper	217		
					Nickel	669		
					Oil & Grease	573		
Envirite [6]	TSDF	NAV	Chemical precipitation Filtration.	F006 K062 D003	Chromium	23	136	<0.01
					Cadmium.	617		
					Copper	137		
					Zinc	135		
					Nickel	382		
					Oil & grease	322		
Envirite [3]	TSDF	NAV	Chemical precipitation Filtration.	F006 K062 D003 D002	Cadmium	10	108	<0.01
					Hex. Chrom	769		
					Chromium	2314		
					Copper	72		
					Zinc	171		
					Nickel	426		
					Oil & grease	113		
Bhattacharyya, et al. [2].	Nonferrous metal production.	NAV	Sulfide and lime precipitation.	NAV	Arsenic	125	75	0.2
					Cadmium	14		
					Mercury	0.8		
Envirite [4]	TSDF	NAV	Chemical precipitation Filtration.	F006 K062 D003 D002	Cadmium	13	64	<0.01
					Hex. Chrom	893		
					Chromium	2581		
					Copper	138		
					Nickel	471		
					Zinc	116		
					Oil & grease	28		
Envirite [5]	TSDF	NAV	Chemical precipitation Filtration.	F006 K062 D003 D002	Cadmium	10	54	<0.10
					Hex. Chrom	807		
					Chromium	2279		
					Copper	133		
					Nickel	470		
					Oil & grease	54		
Chem Pro Inc	NAV	NAV	Chemical precipitation Filtration.	NAV	NAV	NAV	32	<0.5
Battery manufacturing.	Lead battery manufacturing.	NAV	Hydroxide precipitation, Sedimentation.	NAV	NAV	NAV	30	0.11
Envirite [1]	TSDF	NAV	Chemical precipitation Filtration.	F006 K062 D003	Hex. Chrom	917	18	0.01
					Chromium	2236		
					Copper	91		
					Nickel	1414		
					Zinc	71		
					Oil & grease	14		
Metal Finishing Dev. Doc.	Metal finishing	NAV	Chemical precipitation Sedimentation.	NAV	NAV	NAV	9.7	0.14
Metal Finishing Dev. Doc.	Metal finishing	NAV	Chemical precipitation Sedimentation.	NAV	NAV	NAV	8.4	0.10
Metal Finishing Dev. Doc.	Metal finishing	NAV	Chemical precipitation Sedimentation.	NAV	NAV	NAV	6.9	<0.1
Metal Finsithing Dev. Doc.	Metal finishing	NAV	Chemical precipitation Sedimentation.	NAV	NAV	NAV	6.9	0.17

TABLE 8—LEAD DATA FOR WASTEWATER—Continued

Source[+]	Industry	Process generating waste	Treatment process	Waste codes[a]	Waste characterization data		Lead concentration data	
					Parameter	concentration (mg/1)	Untreated Total (mg/1)	Treated Total (mg/1)
Bhattacharyya, et. al. [1].	Nonferrous metal production.	NAV.	Sulfide and lime precipitation.	NAV	Arsenic	160	6.0	<0.2
					Cadmium	3.5		
					Mercury	0.9		

[+] See Section V(C)(10) for Data Sources.
[a] Waste codes as reported in source.
NAV—Not available.

TABLE 9.—LEAD DATA FOR WASTE OTHER THAN WASTEWATER

Source	Industry	Process generating waste	Treatment process	Waste codes	Waste characterization data		Lead concentration data			
					Parameter	Concentration	Untreated		Treated	
							Total (mg/kg)	EP-Tox (mg/l)	Total (mg/kg)	EP-Tox (mg/l)
CBI	CBI	CBI	Stabilization.	NAV	CBI	CBI	96200	NAV	NAV	938
CBI	CBI	CBI	Stabilization.	NAV	CBI	CBI	63150	NAV	NAV	22.8
591	NAV	NAV	Stabilization.	F006	Nickel	4180 mg/kg	57000	125	NAV	0.3
CBI	CBI	CBI	Stabilization.	NAV	CBI	CBI	50500	NAV	NAV	0.2
617	EAF steel	EAF steel production.	Stabilization.	K061	Cadmium	200 ppm	38000	NAV	NAV	0.02–0.03
					Nickel	40 ppm				
					Arsenic	0.03–0.04%				
					TOC	0.04–0.06%				
					Oil and grease.					
CBI	CBI	CBI	Stabilization.	NAV	CBI	CBI	35600	NAV	NAV	0.88
681	EAF steel	EAF steel production.	Stabilization.	K061	Arsenic	50 (mg/gk)	15000	55	000–7000.	<0.01–0.08
					Cadmium	200 mg/gk				
					Selenium	70 mg/gk				
CBI	CBI	CBI	Stabilization.	NAV	CBI	CBI	12500	NAV	NAV	1.19
CBI	CBI	CBI	Stabilization.	NAV	CBI	CBI	11800	NAV	NAV	14.3
CBI	CBI	CBI	Stabilization.	NAV	CBI	CBI	10900	NAV	NAV	3.81
CBI	CBI	CBI	Stabilization.	NAV	CBI	CBI	10900	NAV	NAV	25.8
192[b]	NAP	Synthetic waste.	Stabilization.	NAP	Barium	6600 mg/gk	8820	NAV	NAV	<0.03
					Cadmium	10300 mg/gk				
					Chromium	10900 mg/gk				
					Mercury	11300 mg/gk				
					Nickel	11100 mg/gk				
					Silver	3900 mg/gk				
					Arsenic	12000 mg/gk				
					Selenium	7600 mg/gk				
CBI	CBI	CBI	Stabilization.	NAV	CBI	CBI	7911	NAV	NAV	0.84
CBI	CBI	CBI	Stabilization.	NAV	CBI	CBI	7000	NAV	NAV	0.39
CBI	CBI	CBI	Stabilization.	NAV	CBI	CBI	6450	NAV	NAV	0.98
CBI	CBI	CBI	Stabilization.	NAV	CBI	CBI	6260	NAV	NAV	0.28
CBI	CBI	CBI	Stabilization.	NAV	CBI	CBI	6250	NAV	NAV	1.83
CBI	CBI	CBI	Stabilization.	NAV	CBI	CBI	5581	NAV	NAV	0.36

TABLE 9.—LEAD DATA FOR WASTE OTHER THAN WASTEWATER—Continued

Source	Industry	Process generating waste	Treatment process	Waste codes	Waste characterization data		Lead concentration data			
							Untreated		Treated	
					Parameter	Concentration	Total (mg/kg)	EP-Tox (mg/l)	Total (mg/kg)	EP-Tox (mg/l)
CBI	CBI	CBI	Stabilization.	NAV	CBI	CBI	4689	NAV	NAV	0.3
CBI	CBI	CBI	Stabilization.	NAV	CBI	CBI	4210	NAV	NAV	0.44
CBI	CBI	CBI	Stabilization.	NAV	CBI	CBI	3800	NAV	NAV	3.77
CBI	CBI	CBI	Stabilization.	NAV	CBI	CBI	3630	NAV	NAV	1.13
192[b]	NAP	Synthetic waste.	Stabilization.	NAP	Barium Cadmium Chromium Mercury Nickel Silver Arsenic Selenium	3680 mg/kg 5500 mg/kg 6300 mg/kg 600 mg/kg 5810 mg/kg 1760 mg/kg 6400 mg/kg 4600 mg/kg	3580	NAV	NAV	≤0.03
CBI	CBI	CBI	Stabilization.	NAV	CBI	CBI	3510	NAV	NAV	0.38
CBI	CBI	CBI	Stabilization.	NAV	CBI	CBI	3231	NAV	NAV	0.21
CBI	CBI	CBI	Stabilization.	NAV	CBI	CBI	2729	NAV	NAV	0.45
CBI	CBI	CBI	Stabilization.	NAV	CBI	CBI	2680	NAV	NAV	0.42
CBI	CBI	CBI	Stabilization.	NAV	CBI	CBI	2471	NAV	NAV	1.16
CBI	CBI	CBI	Stabilization.	NAV	CBI	CBI	2471	NAV	NAV	1.76
CBI	CBI	CBI	Stabilization.	NAV	CBI	CBI	2000	NAV	NAV	0.12
CBI	CBI	CBI	Stabilization.	NAV	CBI	CBI	1889	NAV	NAV	0.27
HAZCO[b]	NAP	Synthetic waste.	Stabilization.	NAP	Arsenic Cadmium Mercury Selenium Waste lube oil. Alcohol Water	2267 mg/kg 1090 mg/kg 1752 mg/kg 599 mg/kg 858000 mg/kg 55000 mg/kg 87000 mg/kg	1872	NAV	1813	≤0.5
CBI	CBI	CBI	Stabilization.	NAV	CBI	CBI	1820	NAV	NAV	0.08
CBI	CBI	CBI	Stabilization.	NAV	CBI	CBI	1808	NAV	NAV	0.24
CBI	CBI	CBI	Stabilization.	NAV	CBI	CBI	1725	NAV	NAV	1.05
CBI	CBI	CBI	Stabilization.	NAV	CBI	CBI	1370	NAV	NAV	0.39
CBI	CBI	CBI	Stabilization.	NAV	CBI	CBI	1360	NAV	NAV	1.13
CBI	CBI	CBI	Stabilization.	NAV	CBI	CBI	1300	NAV	NAV	1.7
CBI	CBI	CBI	Stabilization.	NAV	CBI	CBI	1185	NAV	NAV	0.29
192[b]	NAP	Synthetic waste.	Stabilization.	NAP	Barium Cadmium Chromium Mercury Nickel Silver Arsenic Selenium	18 mg/kg 2400 mg/kg 1710 mg/kg 1060 mg/kg 1360 mg/kg 290 mg/kg 1100 mg/kg 750 mg/kg	1170	NAV	NAV	0.08
CBI	CBI	CBI	Stabilization.	NAV	CBI	CBI	1049	NAV	NAV	0.55
CBI	CBI	CBI	Stabilization.	NAV	CBI	CBI	800	NAV	NAV	1.41

TABLE 9.—LEAD DATA FOR WASTE OTHER THAN WASTEWATER—Continued

Source	Industry	Process generating waste	Treatment process	Waste codes	Waste characterization data		Lead concentration data			
							Untreated		Treated	
					Parameter	Concentration	Total (mg/kg)	EP-Tox (mg/l)	Total (mg/kg)	EP-Tox (mg/l)
CBI	CBI	CBI	Stabilization.	NAV	CBI	CBI	663	NAV	NAV	0.62
CBI	CBI	CBI	Stabilization.	NAV	CBI	CBI	597	NAV	NAV	0.7
CBI	CBI	CBI	Stabilization.	NAV	CBI	CBI	596	NAV	NAV	0.6
CBI	CBI	CBI	Stabilization.	NAV	CBI	CBI	577	NAV	NAV	1.82
CBI	CBI	CBI	Stabilization.	NAV	CBI	CBI	484	NAV	NAV	0.42
CBI	CBI	CBI	Stabilization.	NAV	CBI	CBI	448	NAV	NAV	0.41
CBI	CBI	CBI	Stabilization.	NAV	CBI	CBI	362	NAV	NAV	0.365
CBI	CBI	CBI	Stabilization.	NAV	CBI	CBI	360	NAV	NAV	0.41
638	TSDF	NAV	Stabilization.	NAV	Nickel Selenium TOC Oil & grease	291–314 ppm 0.125–51.8 ppm. 3.35–9.58 ppm 5.0%–18.4%	156–334	NAV	NAV	0.02
CBI	CBI	CBI	Stabilization.	NAV	CBI	CBI	332	NAV	NAV	0.33
CBI	CBI	CBI	Stabilization.	NAV	CBI	CBI	327	NAV	NAV	0.37
CBI	CBI	CBI	Stabilization.	NAV	CBI	CBI	288	NAV	NAV	0.39
CBI	CBI	CBI	Stabilization.	NAV	CBI	CBI	275	NAV	NAV	0.245
CBI	CBI	CBI	Stabilization.	NAV	CBI	CBI	270	NAV	NAV	0.3
548	NAV	Electroplating.	Stabilization.	F006	Chromium (tot). Nickel	138000 mg/kg 5610 mg/kg	269	NAV	NAV	0.33
CBI	CBI	CBI	Stabilization.	NAV	CBI	CBI	236	NAV	NAV	0.39
CBI	CBI	CBI	Stabilization.	NAV	CBI	CBI	229	NAV	NAV	0.43
CBI	CBI	CBI	Stabilization.	NAV	CBI	CBI	228	NAV	NAV	0.35
CBI	CBI	CBI	Stabilization.	NAV	CBI	CBI	221	NAV	NAV	0.11
CBI	CBI	CBI	Stabilization.	NAV	CBI	CBI	216	NAV	NAV	0.35
192	TSDF	NAV	Stabilization.	K062 D002 F006 F007 F009 F012	Cadmium Nickel pH	0.11–310 mg/1. 30–124.8 mg/1 ≤1.7.0.	0.12–204 *	NAV	165 *	≤0.06
CBI	CBI	CBI	Stabilization.	NAV	CBI	CBI	203	NAV	NAV	0.35
CBI	CBI	CBI	Stabilization.	NAV	CBI	CBI	198	NAV	NAV	0.34
CBI	CBI	CBI	Stabilization.	NAV	CBI	CBI	190	NAV	NAV	0.01
CBI	CBI	CBI	Stabilization.	NAV	CBI	CBI	186	NAV	NAV	0.29
CBI	CBI	CBI	Stabilization.	NAV	CBI	CBI	182	NAV	NAV	0.02
CBI	CBI	CBI	Stabilization.	NAV	CBI	CBI	181	NAV	NAV	0.48
CBI	CBI	CBI	Stabilization.	NAV	CBI	CBI	180	NAV	NAV	0.205
CBI	CBI	CBI	Stabilization.	NAV	CBI	CBI	180	NAV	NAV	0.26

TABLE 9.—LEAD DATA FOR WASTE OTHER THAN WASTEWATER—Continued

Source	Industry	Process generating waste	Treatment process	Waste codes	Waste characterization data		Lead concentration data			
							Untreated		Treated	
					Parameter	Concentration	Total (mg/kg)	EP-Tox (mg/l)	Total (mg/kg)	EP-Tox (mg/l)
CBI	CBI	CBI	Stabilization.	NAV	CBI	CBI	169	NAV	NAV	0.4
192	TSDF	NAV	Stabilization.	K062 D002 F009 F006 F012 F007 F017 F018	Chromium Nickel	1527 mg/kg 2020 mg/kg	165	NAV	NAV	0.1
CBI	CBI	CBI	Stabilization.	NAV	CBI	CBI	164	NAV	NAV	0.2
CBI	CBI	CBI	Stabilization.	NAV	CBI	CBI	161	NAV	NAV	0.16
CBI	CBI	CBI	Stabilization.	NAV	CBI	CBI	160	NAV	NAV	0.34
CBI	CBI	CBI	Stabilization.	NAV	CBI	CBI	159	NAV	NAV	0.06
CBI	CBI	CBI	Stabilization.	NAV	CBI	CBI	157	NAV	NAV	0.3
548	NAV	Electroplating.	Stabilization.	F006	Chromium Nickel	16700 mg/kg 5050 mg/kg	151	NAV	NAV	0.34
CBI	CBI	CBI	Stabilization.	NAV	CBI	CBI	144	NAV	NAV	0.28
548	NAV	Electroplating.	Stabilization.	F006	Chromium Nickel	15600 mg/kg 5700 mg/kg	144	NAV	NAV	0.34
CBI	CBI	CBI	Stabilization.	NAV	CBI	CBI	138.9	NAV	NAV	0.42
CBI	CBI	CBI	Stabilization.	NAV	CBI	CBI	135	NAV	NAV	0.06
CBI	CBI	CBI	Stabilization.	NAV	CBI	CBI	132	NAV	NAV	0.65
CBI	CBI	CBI	Stabilization.	NAV	CBI	CBI	129	NAV	NAV	0.33
CBI	CBI	CBI	Stabilization.	NAV	CBI	CBI	128	NAV	NAV	0.27
CBI	CBI	CBI	Stabilization.	NAV	CBI	CBI	127	NAV	NAV	0.08
CBI	CBI	CBI	Stabilization.	NAV	CBI	CBI	116	NAV	NAV	0.42
CBI	CBI	CBI	Stabilization.	NAV	CBI	CBI	115	NAV	NAV	0.27
CBI	CBI	CBI	Stabilization.	NAV	CBI	CBI	114	NAV	NAV	0.47
CBI	CBI	CBI	Stabilization.	NAV	CBI	CBI	108	NAV	NAV	0.53
CBI	CBI	CBI	Stabilization.	NAV	CBI	CBI	108	NAV	NAV	0.21
CBI	CBI	CBI	Stabilization.	NAV	CBI	CBI	108	NAV	NAV	0.53
CBI	CBI	CBI	Stabilization.	NAV	CBI	CBI	104	NAV	NAV	0.23

* See Section V(C)(10) for Data Sources.
a Waste code reported in delisting petition.
b Data represents bench-scale test.
NAV—Not available.
NAP—Not applicable.
CBI—Confidential Business Information.

5. Mercury

a. *Data Summary.* The Agency has five data points on the treatment of mercury in wastewater from four facilities. Of the five data points, all have mercury concentrations in the treated wastewater lower than the EP regulatory level of 0.2 mg/l. Table 10 provides a summary of all available data for treatment of mercury. All five data points reflect treatment by chemical precipitation.

The Agency has 102 data points on the treatment of mercury in waste *other*

than wastewater from three facilities. Of the 102 data points, 96 have mercury concentrations in the leachate from the treated waste lower than the EP regulatory level of 0.2 mg/1. Table 11 provides a summary of all available data for mercury in waste other than wastewater. Of the 102 data points, all reflect treatment by stabilization.

b. *Data Analysis—Wastewater.* (i) Waste Characterization Analysis. All data points reflect treatment by chemical precipitation. The Agency has limited data on the range of waste characteristics pertinent to an evaluation of performance of this technology. Most of the available waste characterization data that are important for an engineering analysis involve other metal concentrations.

The treatment data have a maximum influent concentration for mercury of 110 mg/1. Our review of the literature indicates that untreated wastes may have concentrations as high as 132 mg/1, comparable to the maximum influent concentration contained in the data set.

(ii) Design and Operating Parameter Analysis. The five data points were generated by four different facilities that employed chemical precipitation technologies. The Agency has no available design and operating data for any of the treatment facilities.

(iii) Discussion. The Agency's best engineering judgment is that the EP regulatory level of 0.2 mg/1 for mercury can be met for the full range of California List wastewaters containing mercury. In support of this position, the Agency points to theoretical solubility limits, chemical precipitation theory, and our knowledge of the technologies available to minimize the effects of constituents in the waste that can interfere with treatment performance.

Additionally, the available data would not lead us to conclude otherwise.

All five data points show that the EP regulatory level can be achieved. Based on available information, these data cover the range of mercury concentrations that the Agency would expect to be present in untreated California List wastewaters. The Agency recognizes the lack of data on the full range of waste characteristics and design and operating conditions that may affect treatment effectiveness. Therefore, we are soliciting data that would aid the Agency in analyzing treatment effectiveness for mercury in wastewaters. A description of the specific waste characterization data and design and operating data that the Agency needs can be found in Section V(E), Request for Comments.

c. *Data Analysis—Waste Other Than Wastewater.* (i) Waste characterization Analysis. As stated above in the Data Summary, 96 of the 102 data points show that the EP regulatory level for mercury can be achieved. Of the 96 points that achieved the EP regulatory level, all reflect treatment by stabilization. The Agency has limited information on the range of waste characteristics pertinent to an evaluation of the performance of this technology. Most of the available waste characteristics data that are important for an engineering analysis involve other metal concentrations. For the 96 data points which meet EP regulatory levels, the treatment data reflect a maximum untreated level for mercury of 3,720 mg/kg.

(ii) Design and Operating Parameter Analysis. For the 96 data points that achieve the EP regulatory level, the Agency has only limited design and operating data reported from two facilities.

(iii) Discussion. The Agency's best engineering judgment is that the EP regulatory level of 0.2 mg/1 for mercury can be met in leachate for the full range of California List wastes other than wastewaters. In support of this position, the Agency points to the facility's ability to change the ratio of stabilizing agents to waste quantities as needed to decrease mobility of the constituent; this assumes that an effective stabilizing agent and/or additives are available. Additionally, the curing conditions (e.g., length of cure and ambient conditions) can be controlled to ensure that the waste particles have had sufficient time to form a stable treated waste. Additionally, the Agency's evaluation of the available data would not lead us to conclude otherwise.

For the six data points that do not achieve the EP regulatory level, only one has a waste concentration significantly higher than waste concentrations shown to achieve the EP regulatory level. While limited waste characterization data are available, this waste is not shown to contain constituents much different from other wastes which achieve the EP regulatory level. With regard to design and operation of the system, there are no data available to show that the stabilization process for this point was well-designed and operated.

The Agency recognizes that we lack data on the full range of waste characteristics and design and operation conditions that may affect treatment effectiveness. Therefore, we are soliciting information to aid the Agency in analyzing treatment performance for mercury in wastes other than wastewater. The specific waste characteristic data and design and operating data that the Agency needs are described in Section V(E), Request for Comments.

TABLE 10.—MERCURY DATA FOR WASTEWATER

Source [+]	Industry	Process generating waste	Treatment process	Waste codes	Waste characterization data		Mercury concentration data	
					Parameter	Concentration	Untreated	Treated
							Total (mg/l)	Total (mg/l)
Battery Manuf. Dev. Doc.	Zinc battery manufacturing/ Hg0 production.	NAV	Sulfide precipitation.	NAV	NAV	NAV	110	0.06
Battery Manuf. Dev. Doc.	Zinc battery manufacturing.	NAV	Lime precipitation, Settling, Filtration.	NAV	Cadmium Nickel	2.04 mg/l 1,000 mg/l	100	<0.001
Battery Manuf. Dev. Doc.	Lead battery manufacturing.	NAV	Ferrite co-precipitation.	NAV	Cadmium Nickel Lead	240 mg/l 1,000 mg/l 475 mg/l	7.4	0.001
Bhattach aryya, et al. [1].	Nonferrous metal production.	NAV	Sulfide and lime precipitation.	NAV	Arsenic Cadmium Lead	160 3.5 6.0	0.9	0.01

TABLE 10.—MERCURY DATA FOR WASTEWATER—Continued

Source +	Industry	Process generating waste	Treatment process	Waste codes	Waste characterization data		Mercury concentration data	
					Parameter	Concentration	Untreated	Treated
							Total (mg/l)	Total (mg/l)
Bhattach aryya, et al. [2].	Nonferrous metal production.	NAV	Sulfide and lime precipitation.	NAV	Arsenic .... Cadmium .... Lead	125 .... 14 .... 75	0.8	0.012

+ See Section V(C)(10) for Data Sources.
NAV–Not Available.

TABLE 11.—MERCURY DATA FOR WASTE OTHER THAN WASTEWATER

Source +	Industry	Process generating waste	Treatment process	Waste codes	Waste characterization data		Mercury Concentration Data			
					Parameter	Concentration	Untreated	Treated		
							Total (mg/kg)	EP-Tox (mg/l)	Total (mg/kg)	EP-Tox (mg/l)
192 ·.............	NAP............	Synthetic waste.	Stabiliza-tion.	NAP........	Barium.......... Cadmium ..... Chromium.... Lead............ Nickel.......... Silver........... Arsenic........ Selenium......	6600 mg/kg .... 10300 mg/kg........ 10900 mg/kg........ 8820 mg/kg.......... 11100 mg/kg........ 3900 mg/kg.......... 12000 mg/kg........ 7600 mg/kg........	11300	NAV	NAV........	26
CBI	CBI	CBI	Stabiliza-tion.	NAV........	CBI	CBI	3720	NAV	NAV........	0.09
HAZCO ·......	NAP............	Synthetic waste.	Stabiliza-tion.	NAP........	Arsenic.......... Cadmium ..... Lead............ Selenium...... Waste lube oil. Alcohol......... Water	2267 mg/kg .... 1090 mg/kg.......... 1872 mg/kg.......... 599 mg/kg .... 858000 mg/kg...... 55000 mg/kg........ 87000 mg/kg........	1752	NAV	1697	0.07
192 ·.............	NAP............	Synthetic waste.	Stabiliza-tion.	NAP........	Barium.......... Cadmium ..... Chromium.... Lead............ Nickel.......... Silver........... Arsenic........ Selenium......	18 mg/kg .... 2400 mg/kg.......... 1710 mg/kg.......... 1170 mg/kg.......... 1360 mg/kg.......... 290 mg/kg .... 1100 mg/kg.......... 750 mg/kg	1060	NAV	NAV........	9.4
192 ·.............	NAP............	Synthetic waste.	Stabiliza-tion.	NAP........	Barium.......... Cadmium ..... Chromium.... Lead............ Nickel.......... Silver........... Arsenic........ Selenium......	3680 mg/kg.......... 5500 mg/kg.......... 6300 mg/kg.......... 3580 mg/kg.......... 5810 mg/kg.......... 1760 mg/kg.......... 6400 mg/kg.......... 4600 mg/kg..........	600	NAV	NAV........	8.6
CBI	CBI	CBI	Stabiliza-tion.	NAV........	CBI	CBI	554.2	NAV	NAV........	0.008
CBI	CBI	CBI	Stabiliza-tion.	NAV........	CBI	CBI	253	NAV	NAV........	0.11
CBI	CBI	CBI	Stabiliza-tion.	NAV........	CBI	CBI	243	NAV	NAV........	0.009
CBI	CBI	CBI	Stabiliza-tion.	NAV........	CBI	CBI	105	NAV	NAV........	0.01
CBI	CBI	CBI	Stabiliza-tion.	NAV........	CBI	CBI	90	NAV	NAV........	0.002
CBI	CBI	CBI	Stabiliza-tion.	NAV........	CBI	CBI	84.3	NAV	NAV........	0.001
CBI	CBI	CBI	Stabiliza-tion.	NAV........	CBI	CBI	64.9	NAV	NAV........	0.001

TABLE 11.—MERCURY DATA FOR WASTE OTHER THAN WASTEWATER—Continued

Source +	Industry	Process generating waste	Treatment process	Waste codes	Waste characterization data		Mercury Concentration Data			
					Parameter	Concentration	Untreated		Treated	
							Total (mg/kg)	EP-Tox (mg/l)	Total (mg/kg)	EP-Tox (mg/l)
CBI	CBI	CBI	Stabilization.	NAV	CBI	CBI	50	NAV	NAV	0.01
CBI	CBI	CBI	Stabilization.	NAV	CBI	CBI	49	NAV	NAV	0.008
CBI	CBI	CBI	Stabilization.	NAV	CBI	CBI	44	NAV	NAV	0.17
CBI	CBI	CBI	Stabilization.	NAV	CBI	CBI	41	NAV	NAV	12
CBI	CBI	CBI	Stabilization.	NAV	CBI	CBI	40	NAV	NAV	0.02
CBI	CBI	CBI	Stabilization.	NAV	CBI	CBI	40	NAV	NAV	0.18
CBI	CBI	CBI	Stabilization.	NAV	CBI	CBI	38	NAV	NAV	0.02
CBI	CBI	CBI	Stabilization.	NAV	CBI	CBI	35	NAV	NAV	0.05
CBI	CBI	CBI	Stabilization.	NAV	CBI	CBI	35	NAV	NAV	0.03
CBI	CBI	CBI	Stabilization.	NAV	CBI	CBI	34	NAV	NAV	0.05
CBI	CBI	CBI	Stabilization.	NAV	CBI	CBI	33	NAV	NAV	0.12
CBI	CBI	CBI	Stabilization.	NAV	CBI	CBI	32	NAV	NAV	0.1
CBI	CBI	CBI	Stabilization.	NAV	CBI	CBI	31	NAV	NAV	0.011
CBI	CBI	CBI	Stabilization.	NAV	CBI	CBI	29	NAV	NAV	0.04
CBI	CBI	CBI	Stabilization.	NAV	CBI	CBI	29	NAV	NAV	0.11
CBI	CBI	CBI	Stabilization.	NAV	CBI	CBI	28	NAV	NAV	0.11
CBI	CBI	CBI	Stabilization.	NAV	CBI	CBI	25.48	NAV	NAV	0.0058
CBI	CBI	CBI	Stabilization.	NAV	CBI	CBI	25	NAV	NAV	0.02
CBI	CBI	CBI	Stabilization.	NAV	CBI	CBI	24	NAV	NAV	0.03
CBI	CBI	CBI	Stabilization.	NAV	CBI	CBI	23	NAV	NAV	0.03
CBI	CBI	CBI	Stabilization.	NAV	CBI	CBI	22	NAV	NAV	0.09
CBI	CBI	CBI	Stabilization.	NAV	CBI	CBI	22	NAV	NAV	0.14
CBI	CBI	CBI	Stabilization.	NAV	CBI	CBI	21	NAV	NAV	0.11
CBI	CBI	CBI	Stabilization.	NAV	CBI	CBI	21	NAV	NAV	0.12
CBI	CBI	CBI	Stabilization.	NAV	CBI	CBI	20	NAV	NAV	0.02
CBI	CBI	CBI	Stabilization.	NAV	CBI	CBI	20	NAV	NAV	0.19
CBI	CBI	CBI	Stabilization.	NAV	CBI	CBI	19	NAV	NAV	0.08
CBI	CBI	CBI	Stabilization.	NAV	CBI	CBI	19	NAV	NAV	0.03
CBI	CBI	CBI	Stabilization.	NAV	CBI	CBI	19	NAV	NAV	0.08
CBI	CBI	CBI	Stabilization.	NAV	CBI	CBI	18	NAV	NAV	0.09
CBI	CBI	CBI	Stabilization.	NAV	CBI	CBI	18	NAV	NAV	0.13
CBI	CBI	CBI	Stabilization.	NAV	CBI	CBI	18	NAV	NAV	0.02
CBI	CBI	CBI	Stabilization.	NAV	CBI	CBI	17	NAV	NAV	0.14

TABLE 11.—MERCURY DATA FOR WASTE OTHER THAN WASTEWATER—Continued

Source +	Industry	Process generating waste	Treatment process	Waste codes	Waste characterization data		Mercury Concentration Data			
							Untreated		Treated	
					Parameter	Concentration	Total (mg/kg)	EP-Tox (mg/l)	Total (mg/kg)	EP-Tox (mg/l)
CBI	CBI	CBI	Stabilization.	NAV	CBI	CBI	17	NAV	NAV	0.09
CBI	CBI	CBI	Stabilization.	NAV	CBI	CBI	16	NAV	NAV	0.21
CBI	CBI	CBI	Stabilization.	NAV	CBI	CBI	16	NAV	NAV	0.08
CBI	CBI	CBI	Stabilization.	NAV	CBI	CBI	15.22	NAV	NAV	0.0087
CBI	CBI	CBI	Stabilization.	NAV	CBI	CBI	14	NAV	NAV	0.12
CBI	CBI	CBI	Stabilization.	NAV	CBI	CBI	14	NAV	NAV	0.02
CBI	CBI	CBI	Stabilization.	NAV	CBI	CBI	13.6	NAV	NAV	0.0165
CBI	CBI	CBI	Stabilization.	NAV	CBI	CBI	12.83	NAV	NAV	0.001
CBI	CBI	CBI	Stabilization.	NAV	CBI	CBI	12	NAV	NAV	0.09
CBI	CBI	CBI	Stabilization.	NAV	CBI	CBI	12	NAV	NAV	0.08
CBI	CBI	CBI	Stabilization.	NAV	CBI	CBI	12	NAV	NAV	0.05
CBI	CBI	CBI	Stabilization.	NAV	CBI	CBI	12	NAV	NAV	0.11
CBI	CBI	CBI	Stabilization.	NAV	CBI	CBI	11	NAV	NAV	0.11
CBI	CBI	CBI	Stabilization.	NAV	CBI	CBI	11	NAV	NAV	0.07
CBI	CBI	CBI	Stabilization.	NAV	CBI	CBI	11	NAV	NAV	0.03
CBI	CBI	CBI	Stabilization.	NAV	CBI	CBI	10.4	NAV	NAV	0.0174
CBI	CBI	CBI	Stabilization.	NAV	CBI	CBI	10.3	NAV	NAV	0.006
CBI	CBI	CBI	Stabilization.	NAV	CBI	CBI	10	NAV	NAV	0.08
CBI	CBI	CBI	Stabilization.	NAV	CBI	CBI	10	NAV	NAV	0.04
CBI	CBI	CBI	Stabilization.	NAV	CBI	CBI	10	NAV	NAV	0.9
CBI	CBI	CBI	Stabilization.	NAV	CBI	CBI	10	NAV	NAV	0.14
CBI	CBI	CBI	Stabilization.	NAV	CBI	CBI	9.4	NAV	NAV	0.002
CBI	CBI	CBI	Stabilization.	NAV	CBI	CBI	9.38	NAV	NAV	0.0104
CBI	CBI	CBI	Stabilization.	NAV	CBI	CBI	8.8	NAV	NAV	0.0085
CBI	CBI	CBI	Stabilization.	NAV	CBI	CBI	8.6	NAV	NAV	0.0096
CBI	CBI	CBI	Stabilization.	NAV	CBI	CBI	8.5	NAV	NAV	0.0095
CBI	CBI	CBI	Stabilization.	NAV	CBI	CBI	8.03	NAV	NAV	0.0109
CBI	CBI	CBI	Stabilization.	NAV	CBI	CBI	8	NAV	NAV	0.03
CBI	CBI	CBI	Stabilization.	NAV	CBI	CBI	8	NAV	NAV	0.09
CBI	CBI	CBI	Stabilization.	NAV	CBI	CBI	8	NAV	NAV	0.04
CBI	CBI	CBI	Stabilization.	NAV	CBI	CBI	8.1	NAV	NAV	0.045
CBI	CBI	CBI	Stabilization.	NAV	CBI	CBI	7.91	NAV	NAV	0.0013
CBI	CBI	CBI	Stabilization.	NAV	CBI	CBI	7.32	NAV	NAV	0.0019

TABLE 11.—MERCURY DATA FOR WASTE OTHER THAN WASTEWATER—Continued

Source[+]	Industry	Process generating waste	Treatment process	Waste codes	Waste characterization data		Mercury Concentration Data			
					Parameter	Concentration	Untreated		Treated	
							Total (mg/kg)	EP-Tox (mg/l)	Total (mg/kg)	EP-Tox (mg/l)
CBI	CBI	CBI	Stabilization.	NAV	CBI	CBI	7.24	NAV	NAV	0.0231
CBI	CBI	CBI	Stabilization.	NAV	CBI	CBI	7	NAV	NAV	0.06
CBI	CBI	CBI	Stabilization.	NAV	CBI	CBI	6.98	NAV	NAV	0.0096
CBI	CBI	CBI	Stabilization.	NAV	CBI	CBI	6.67	NAV	NAV	0.0073
CBI	CBI	CBI	Stabilization.	NAV	CBI	CBI	6.62	NAV	NAV	0.0048
CBI	CBI	CBI	Stabilization.	NAV	CBI	CBI	6.2	NAV	NAV	0.0043
CBI	CBI	CBI	Stabilization.	NAV	CBI	CBI	6.1	NAV	NAV	0.002
CBI	CBI	CBI	Stabilization.	NAV	CBI	CBI	6.1	NAV	NAV	0.0092
CBI	CBI	CBI	Stabilization.	NAV	CBI	CBI	6	NAV	NAV	0.05
CBI	CBI	CBI	Stabilization.	NAV	CBI	CBI	6	NAV	NAV	0.02
CBI	CBI	CBI	Stabilization.	NAV	CBI	CBI	6	NAV	NAV	0.09
CBI	CBI	CBI	Stabilization.	NAV	CBI	CBI	6	NAV	NAV	0.050
CBI	CBI	CBI	Stabilization.	NAV	CBI	CBI	5.9	NAV	NAV	0.002
CBI	CBI	CBI	Stabilization.	NAV	CBI	CBI	5.86	NAV	NAV	0.0024
CBI	CBI	CBI	Stabilization.	NAV	CBI	CBI	5.8	NAV	NAV	0.01
CBI	CBI	CBI	Stabilization.	NAV	CBI	CBI	5.74	NAV	NAV	0.0051
CBI	CBI	CBI	Stabilization.	NAV	CBI	CBI	5.1	NAV	NAV	0.0085
CBI	CBI	CBI	Stabilization.	NAV	CBI	CBI	5	NAV	NAV	0.02
CBI	CBI	CBI	Stabilization.	NAV	CBI	CBI	5	NAV	NAV	0.06
CBI	CBI	CBI	Stabilization.	NAV	CBI	CBI	5	NAV	NAV	0.021
CBI	CBI	CBI	Stabilization.	NAV	CBI	CBI	5	NAV	NAV	0.05
CBI	CBI	CBI	Stabilization.	NAV	CBI	CBI	4.91	NAV	NAV	0.0011
CBI	CBI	CBI	Stabilization.	NAV	CBI	CBI	4.23	NAV	NAV	0.0163
CBI	CBI	CBI	Stabilization.	NAV	CBI	CBI	4.1	NAV	NAV	0.007

[+] See Section V(C)(10) for Data Sources.
[b] Data represents bench-scale test.
NAV—Not available.
NAP—Not applicable.
CBI—Confidential Business Information.

6. Nickel

a. *Data Summary.* The Agency has 35 data points on the treatment of nickel in wastewater from 25 facilities. Of the 35 data points, 34 have nickel concentrations in the treated wastewater lower than the health-based value of 50 mg/1. The treatment technology applied to these wastewaters was chemical precipitation. Table 12 provides a summary of all available data on the treatment of nickel in wastewater.

The Agency has 40 data points on the treatment of nickel in waste *other than wastewater* from six facilities. Of the 40 data points, 38 have nickel lower than the health-based prohibition levels of 50 mg/1. The treatment technology applied to these wastes was stabilization. Table 13 provides a summary of all available data for nickel in waste other than wastewater.

b. *Data Analysis—Wastewater.*

(i) Waste Characteristic Analysis. Of the 34 data points that achieve the health-based prohibition level, all reflect treatment by chemical precipitation. The

Agency has limited data on the range of waste characteristics pertinent to an evaluation of the performance of this technology. Most of the available waste characterization data that are important for engineering analysis involve other metal concentrations.

The treatment data have a maximum influent concentration for nickel of 65,000 mg/1. As stated in Section V(B)(1), high influent concentrations, per se, do not adversely affect treatment; however, high metal concentration often indicate that the metals are complexed in solution and complexed metal compounds, if not dissociated, could have an adverse effect on treatment.

(ii) *Design and Operating Parameter Analysis.* Of the 34 data points that meet the health-based prohibition level, the Agency has some design and operating data for two data points from two facilities that document the operation of the treatment system. Limited design and operating data are available for the data point that does not meet the health-based prohibition level.

(iii) *Discussion.* The Agency's best engineering judgment is that the health-based prohibition level of 50 mg/1 for nickel can be met for the full range of California List wastes containing nickel. In support of this position, the Agency points to the theoretical solubility limit of nickel precipitates, chemical precipitation theory, and our knowledge of the technologies available to minimize the effects of constituents in the waste that can interfere with treatment performance. Additionally, the available data would not lead us to conclude otherwise.

In the case of the data point that does not show achievement of the health-based prohibition level, the Agency looked at the waste characteristics and treatment design and operation to determine why the health-based prohibition level was not attained. The only waste characteristic data reported for this point was an oil and grease concentration of 150 mg/1. This level may have been sufficient to interfere with the precipitation process; we would expect that oil and grease can be effectively removed by preliminary

treatment such as oil-water separation and/or emulsion breaking.

With regard to our analysis of the design and operation of the treatment system used, the Agency had limited data to determine whether poor design or operation contributed to the failure of the system to achieve the health-based prohibition level.

The Agency recognizes that we lack data on the full range of waste characterization and design and operation conditions that may affect treatment effectiveness. Therefore, we are soliciting information to aid the Agency in analyzing treatment performance for nickel in wastewater. The specific waste characteristics data and design and operating data that the Agency needs are described in Section V(E), Request for Comments.

c. *Data Analysis—Waste Other Than Wastewater.* (i) Waste Characteristics Analysis. As stated above in the Data Summary, 38 of the 40 data points achieve the health-based prohibition level for nickel. All 40 data points reflect treatment by stabilization.

For the 38 data points, the Agency has limited information on the range of waste characteristics pertinent to an evaluation of the performance of this technology. Most of the available waste characterization data that are important for an engineering analysis involve other metal concentrations.

For wastes that were treated to below the health-based prohibition level, the maximum total nickel concentration was 65,000 mg/kg.

(ii) Design and Operating Parameter Analysis. For the 38 data points that achieve the health-based value, the Agency has limited design and operating data for 10 data points from two facilities. For the two data points that do not meet the health-based prohibition level, we have insufficient information to determine whether poor design or operation affected performance.

(iii) Discussion. The Agency's best engineering judgment is that the health-based prohibition level of 50 mg/1 for nickel can be met in leachate for the full range of California List wastes other than wastewater. In support of this position, the Agency points to the

facility's ability to change the ratio of stabilizing agents to waste quantities as needed to decrease the mobility of the constituent; this assumes that an effective stabilizing agent and/or additives are available. Additionally, the curing conditions (e.g., length of cure and ambient conditions) can be controlled to ensure that the waste particles have had sufficient time to form a stable treated waste. Additionally, the Agency's evaluation of the available data also would not lead us to conclude that the health-based prohibition level of 50 mg/1 cannot be achieved.

In the cases where the treated waste leachate did not achieve the health-based prohibition level, the Agency looked at the waste characteristics and treatment design and operation to determine why the health-based prohibition level was not attained. Relative to waste characteristics, one of the two data points had untreated waste with high concentrations of various other metals that could have had an adverse affect on the performance of the stabilization technology. The EPA has no waste characteristic data on other parameters in these wastes, such as oil and grease content, organic compounds, and sulfates, all of which can adversely affect the performance of stabilization technology if not adequately removed or immobilized prior to or during stabilization. Relative to analysis of the design and operation of the treatment system used, the Agency has insufficient data to determine whether poor design or operation contributed to the failure of the systems to achieve the health-based prohibition level.

The Agency recognizes that we lack data on the full range of waste characteristics and design and operation conditions that may affect treatment effectiveness. Therefore, we are soliciting information to aid the Agency in analyzing treatment performance for nickel in wastes other than wastewater. The specific waste characteristics data and design and operating data that the Agency needs are described in Section V(E), Request for Comments.

TABLE 12.—NICKEL DATA FOR WASTEWATER

Source*	Industry	Process generating waste	Treatment process	Waste codes[a]	Waste Characterization Data		Nickel concentration data	
					Parameter	Concentration (mg/l)	Untreated Total (mg/l)	Treated Total (mg/l)
Envirite [2]	TSDF	NAV	Chemical precipitation, Filtration.	F006 K062 D003 D002	Hex. Chrom. Chromium Copper Zinc Oil & Grease	775 1990 133 3.9 0.25	16330	0.33
Envirite [1]	TSDF	NAV	Chemical precipitation, Filtration.	D002 K062 D003	Hex. Chrom. Chromium Copper Zinc Oil & Grease	0.6 556 88 84 16	6610	0.33
EWE	Electronic & plating	NAV	Chemical precipitation.	NAV	Oil & grease	150	3700	130
Envirite [3]	TSDF	NAV	Chemical precipitation, Filtration.	F006 K062 D003	Hex. Chrom. Chromium Copper Lead Zinc Oil & grease	917 2236 91 18 71 14	1414	0.31
Battery Manufacturing Dev. Doc.	Zinc battery manufacturing.	NAV	Lime precipitation. Settling. Filtration.	NAV	Cadmium Mercury	2.04 100	1100	0.5
Battery Manufacturing Dev. Doc.	Lead battery manufacturing.	NAV	Ferrite coprecipitation.	NAV	Cadmium Lead Mercury	240 475 7.4	1000	0.2
Envirite [9]	TSDF	NAV	Chemical precipitation, Filtration.	D002 F006 D003	Chromium Copper Oil & grease	939 225 204	940	0.33
Envirite [10]	TSDF	NAV	Chemical precipitation, Filtration.	F006 K062 D003	Chromium Copper Oil & grease	395 191 0.035	712	0.33
Envirite [4]	TSDF	NAV	Chemical precipitation, Filtration.	F006 D003 K062	Hex. chrom Chromium Copper Lead Zinc	0.13 831 217 212 151	669	0.36
Envirite [5]	TSDF	NAV	Chemical precipitation, Filtration.	F011 K062 D003 D002	Hex. Chrom. Chromium Copper Zinc Oil & grease	734 2548 149 4 102	588	0.33
Frontier Chemical Company.	Battery manufacturing.	NAV	Chromium reduction, Lime precipitation, Filtration, Carbon adsorption.	D002 D007	TOC Oil & grease TSS TDS Lead Cadmium	5600–19000 2600–18000 2400–60000 10000–170000 1.1–3.8 3.9–180	4.3–500	1.8–2.2
Envirite [6]	TSDF	NAV	Chemical precipitation, Filtration.	F006 K062 D003 D002	Cadmium Hex. Chrom. Chromium Copper Lead Zinc Oil & grease	13 893 2581 138 64 116 28	471	0.33
Envirite [7]	TSDF	NAV	Chemical precipitation, Filtration.	F006 K062 D003 D002	Cadmium Hex. Chrom. Chromium Copper Lead Oil & grease	10 807 2279 133 116 54	470	0.33

TABLE 12.—NICKEL DATA FOR WASTEWATER—Continued

Source*	Industry	Process generating waste	Treatment process	Waste codes[a]	Waste Characterization Data		Nickel concentration data	
					Parameter	Concentration (mg/l)	Untreated Total (mg/l)	Treated Total (mg/l)
Envirite [8]	TSDF	NAV	Chemical precipitation, Filtration.	F006 K062 D003 D002	Cadmium Hex. Chrom. Chromium Copper Zinc Lead Oil & grease	10 769 2314 72 171 108 113	426	0.4
Envirite [11]	TSDF	NAV	Chemical precipitation, Filtration.	F006 K062 D003	Cadmium Chromium Copper Lead Zinc Oil & grease	23 617 137 136 135 322	382	0.39
Metal Finishing Dev. Doc.	Metal finishing	NAV	Chemical precipitation, Sedimentation.	NAV	NAV	NAV	167	0.3
Metal Finishing Dev. Doc.	Metal finishing	NAV	Chemical precipitation, Sedimentation.	NAV	NAV	NAV	153	0.91
Metal Finishing Dev. Doc.	Metal finishing	NAV	Chemical precipitation, Sedimentation.	NAV	NAV	NAV	142	1.56
Metal Finishing Dev. Doc.	Metal finishing	NAV	Chemical precipitation, Sedimentation.	NAV	NAV	NAV	128	0.57
Metal Finishing Dev. Doc.	Metal finishing	NAV	Chemical precipitation, Sedimentation.	NAV	NAV	NAV	111	0.46
Metal Finishing Dev. Doc.	Metal finishing	NAV	Chemical precipitation, Sedimentation.	NAV	NAV	NAV	108	1.78
Metal Finishing Dev. Doc.	Metal finishing	NAV	Chemical precipitation, Sedimentation.	NAV	NAV	NAV	108	0.78
Metal Finishing Dev. Doc.	Metal finishing	NAV	Chemical precipitation, Sedimentation.	NAV	NAV	NAV	97	0.81
Metal Finishing Dev. Doc.	Metal finishing	NAV	Chemical precipitation, Sedimentation.	NAV	NAV	NAV	94	1.52
Metal Finishing Dev. Doc.	Metal finishing	NAV	Chemical precipitation, Sedimentation.	NAV	NAV	NAV	94	0.60
Metal Finishing Dev. Doc.	Metal finishing	NAV	Chemical precipitation, Sedimentation.	NAV	NAV	NAV	85.3	0.14
Metal Finishing Dev. Doc.	Metal finishing	NAV	Chemical precipitation, Sedimentation.	NAV	NAV	NAV	80.6	1.84

TABLE 12.—NICKEL DATA FOR WASTEWATER—Continued

Source*	Industry	Process generating waste	Treatment process	Waste codes[a]	Waste Characterization Data		Nickel concentration data	
					Parameter	Concentration (mg/l)	Untreated	Treated
							Total (mg/l)	Total (mg/l)
Metal Finishing Dev. Doc.	Metal finishing	NAV	Chemical precipitation, Sedimentation.	NAV	NAV	NAV	78.7	0.43
Metal Finishing Dev. Doc.	Metal finishing	NAV	Chemical precipitation, Sedimentation.	NAV	NAV	NAV	78.7	0.11
Metal Finishing Dev. Doc.	Metal finishing	NAV	Chemical precipitation, Sedimentation.	NAV	NAV	NAV	76.9	0.38
Metal Finishing Dev. Doc.	Metal finishing	NAV	Chemical precipitation, Sedimentation.	NAV	NAV	NAV	73.0	6.39
Battery Manufacturing Dev. Doc.	Zinc battery manufacturing.	NAV	Lime precipitation, Settling, Filtration.	NAV	NAV	NAV	59.0	1.76
Metal Finishing Dev. Doc.	Metal finishing	NAV	Chemical precipitation, Sedimentation.	NAV	NAV	NAV	53.8	0.45
Metal Finishing Dev. Doc.	Metal finishing	NAV	Chemical precipitation, Sedimentation.	NAV	NAV	NAV	52.5	0.48
Metal Finishing Dev. Doc.	Metal finishing	NAV	Chemical precipitation, Sedimentation.	NAV	NAV	NAV	50.0	7.30

* See Section V(C)(10) for Data Sources.
[a] Waste codes as reported in source.
NAV—Not available.

TABLE 13. NICKEL DATA FOR WASTE OTHER THAN WASTEWATER

Source[+]	Industry	Process generating waste	Treatment process	Waste codes[a]	Waste characterization data		Nickel concentration data			
					Parameter	Concentration	Untreated		Treated	
							Total (mg/kg)	EP-Tox (mg/l)	Total (mg/kg)	EP-Tox (mg/l)
161	NAV	Electroplating.	Stabilization.	F006	Chromium	72000 mg/kg	65000	87	NAV	4.8
591	NAV	NAV	Stabilization.	F006	Lead	42200 mg/kg	13100	60	NAV	5.3
192 [b]	NAP	Synthetic waste.	Stabilization.	NAP	Barium Cadmium Chromium Lead Mercury Silver Arsenic Selenium	6600 mg/kg 10300 mg/kg 10900 mg/kg 8820 mg/kg 11300 mg/kg 3900 mg/kg 12000 mg/kg 7600 mg/kg	11100	NAV	NAV	59.7
CBI	CBI	CBI	Stabilization.	NAV	CBI	CBI	8432	NAV	NAV	1.19
548	NAV	Electroplating.	Stabilization.	F006	Chromium	16900 mg/kg	6120	NAV	NAV	0.454
CBI	CBI	CBI	Stabilization.	NAV	CBI	CBI	6013	NAV	NAV	5.85

TABLE 13. NICKEL DATA FOR WASTE OTHER THAN WASTEWATER—Continued

Source [+]	Industry	Process generating waste	Treatment process	Waste codes [a]	Waste characterization data		Nickel concentration data			
							Untreated		Treated	
					Parameter	Concentration	Total (mg/kg)	EP-Tox (mg/l)	Total (mg/kg)	EP-Tox (mg/l)
548	NAV	Electroplating.	Stabilization.	F006	Chromium	15100 mg/kg	6010	NAV	NAV	0.377
192 [b]	NAP	Synthetic waste.	Stabilization.	NAP	Barium	3680 mg/kg	5810	NAV	NAV	9.0
					Cadmium	5500 mg/kg				
					Chromium	6300 mg/kg				
					Lead	3580 mg/kg				
					Mercury	600 mg/kg				
					Silver	1760 mg/kg				
					Arsenic	6400 mg/kg				
					Selenium	4600 mg/kg				
CBI	CBI	CBI	Stabilization.	NAV	CBI	CBI	5733	NAV	NAV	6.60
548	NAV	Electroplating.	Stabilization.	F006	Chromium	15600 mg/kg	5700	NAV	NAV	0.364
					Lead	144 mg/kg				
CBI	CBI	CBI	Stabilization.	NAV	CBI	CBI	5700	NAV	NAV	5.85
548	NAV	Electroplating.	Stabilization.	F006	Chromium	13800 mg/kg	5610	NAV	NAV	0.352
					Lead	269 mg/kg				
CBI	CBI	CBI	Stabilization.	NAV	CBI	CBI	5388	NAV	NAV	2.26
548	NAV	Electroplating.	Stabilization.	F006	Chromium	16700 mg/kg	5050	NAV	NAV	0.313
					Lead	151 mg/kg				
CBI	CBI	CBI	Stabilization.	NAV	CBI	CBI	4818	NAV	NAV	3.64
CBI	CBI	CBI	Stabilization.	NAV	CBI	CBI	4810	NAV	NAV	0.45
CBI	CBI	CBI	Stabilization.	NAV	CBI	CBI	4280	NAV	NAV	0.52
CBI	CBI	CBI	Stabilization.	NAV	CBI	CBI	3740	NAV	NAV	0.86
CBI	CBI	CBI	Stabilization.	NAV	CBI	CBI	3720	NAV	NAV	0.45
CBI	CBI	CBI	Stabilization.	NAV	CBI	CBI	3530	NAV	NAV	0.46
CBI	CBI	CBI	Stabilization.	NAV	CBI	CBI	3220	NAV	NAV	0.94
192	TSDF	NAV	Stabilization.	K062	Chromium	3300 mg/kg	3200	NAV	NAV	15
				D002	Iron	30600 mg/kg				
				F009	Zinc	16000 mg/kg				
				F006						
				F012						
				F007						
				F017						
				F018						
548	NAV	Electroplating.	Stabilization.	F006	Chromium	9720 mg/kg	3150	NAV	NAV	0.361
CBI	CBI	CBI	Stabilization.	NAV	CBI	CBI	3088	NAV	NAV	0.09
548	NAV	Electroplating.	Stabilization.	F006	Chromium	9070 mg/kg	2920	NAV	NAV	0.288
CBI	CBI	CBI	Stabilization.	NAV	CBI	CBI	2780	NAV	NAV	2.67
548	NAV	Electroplating.	Stabilization.	F006	Chromium	9000 mg/kg	2780	NAV	NAV	0.341
CBI	CBI	CBI	Stabilization.	NAV	CBI	CBI	2680	NAV	NAV	0.62
CBI	CBI	CBI	Stabilization.	NAV	CBI	CBI	2670	NAV	NAV	0.70
548	NAV	Electroplating.	Stabilization.	F006	Chromium	8580 mg/kg	2590	NAV	NAV	0.366
CBI	CBI	CBI	Stabilization.	NAV	CBI	CBI	2587	NAV	NAV	2.67
CBI	CBI	CBI	Stabilization.	NAV	CBI	CBI	2430	NAV	NAV	0.92
CBI	CBI	CBI	Stabilization.	NAV	CBI	CBI	2160	NAV	NAV	0.42

TABLE 13. NICKEL DATA FOR WASTE OTHER THAN WASTEWATER—Continued

Source [+]	Industry	Process generating waste	Treatment process	Waste codes [a]	Waste characterization data		Nickel concentration data			
							Untreated		Treated	
					Parameter	Concentration	Total (mg/kg)	EP-Tox (mg/l)	Total (mg/kg)	EP-Tox (mg/l)
CBI	CBI	CBI	Stabilization.	NAV	CBI	CBI	2100	NAV	NAV	0.75
192	TSDF	NAV	Stabilization.	K062 D002 F009 F006 F012 F007 F017 F018	Chromium Iron	1527 mg/kg 165 mg/kg	2020	NAV	NAV	60
CBI	CBI	CBI	Stabilization.	NAV	CBI	CBI	1930	NAV	NAV	0.90
CBI	CBI	CBI	Stabilization.	NAV	CBI	CBI	1700	NAV	NAV	0.71
CBI	CBI	CBI	Stabilization.	NAV	CBI	CBI	1650	NAV	NAV	0.58
192 [b]	NAP	Synthetic waste.	Stabilization.	NAP	Barium Cadmium Chromium Lead Mercury Silver Arsenic Selenium	18 mg/kg 2400 mg/kg 1710 mg/kg 1170 mg/kg 1060 mg/kg 290 mg/kg 1100 mg/kg 750 mg/kg	1360	NAV	NAV	1.04
CBI	CBI	CBI	Stabilization.	NAV	CBI	CBI	1180	NAV	NAV	0.52

[+] See Section V(C)(10) for Data Sources.
[a] Waste codes as reported in source.
[b] Data represent bench-scale test.
NAV—Not available.
NAP—Not applicable.
CBI—Confidential Business Information.

7. Selenium

a. *Data Summary.* The Agency has three data points on treatment of selenium in wastewaters from three facilities. All three are lower than the EP regulatory level of 1.0 mg/1. Table 14 provides a summary of all available data for the treatment of selenium in wastewater.

The Agency has 19 data points on the treatment of selenium in waste *other than wastewater* from six facilities. Of the 19 data points, 16 are lower than the EP regulatory level of 1.0 mg/1. Table 15 provides a summary of all available data for the treatment of selenium in waste other than wastewater.

b. *Data Analysis—Wastewater.* (i) Waste Characteristic Analysis. As stated above, all three of the data points show that the EP regulatory level for selenium in wastewaters can be achieved. All three data points reflect treatment by either lime and/or sodium hydroxide precipitation.

The Agency has limited data on the range of waste characteristics pertinent to an evaluation of the performance of chemical precipitation technology. Most of the available waste characterization data that are important for an engineering analysis involve other metal concentrations.

(ii) Design and Operating Parameters Analysis. Design and operating data were not available for the three data points presented in Table 14.

(iii) Discussion. The Agency's best engineering judgment is that the EP regulatory level of 1.0 mg/1 for selenium can be met for the full range of California List wastes containing selenium. In support of this position, the Agency points to the theoretical solubility limit of selenium precipitates, chemical precipitation theory, and our knowledge of the technologies available to minimize the effects of constituents in the waste that can interfere with treatment performance. Additionally, the available data would not lead us to conclude otherwise.

The Agency recognizes the lack of data on the full range of waste characteristics and design and operating conditions that may affect treatment effectiveness. Therefore, we are soliciting data that would aid the Agency in analyzing treatment performance for cadmium in wastewaters. A description of the specific waste characterization data and design and operating data that the Agency needs can be found in Section V(E), Request for Comments.

c. *Data Analysis—Waste Other Than Wastewater.* (i) Waste Characteristic Analysis. As stated above in the Data Summary, 16 of the 19 data points achieve the EP regulatory level. Each of these uses stabilization technology for treatment. Of the 16 data points that achieve the EP regulatory level, the Agency has limited data on the range of waste characteristics pertinent to an evaluation of this technology. Most of the available waste characterization data that are important for an engineering analysis involve other metals and oil and grease concentrations. For the wastes where EP regulatory levels were achieved, the maximum total selenium concentration was 1000 mg/kg, while other data indicate that these wastes may contain

total selenium concentrations as high as 7,600 mg/kg. The data with 7,600 selenium in the untreated waste represents bench scale treatment results.

(ii) Design and Operating Parameters Analysis. For the 16 data points that achieve the EP regulatory level, the Agency has limited design and operating data for four data points from four facilities. Three of these data points represent bench scale data.

(iii) Discussion. The Agency's best engineering judgment is that the EP regulatory level of 1.0 mg/1 for selenium can be met in leachate for the full range of California List waste other than wastewater. In support of this position, the Agency points to the ability of the facility to increase the ratio of stabilizing agents to waste as needed to meet high concentration wastes. Additionally, the curing conditions (e.g., length of cure and ambient conditions) can be controlled to ensure that the waste particles have had sufficient time to form a stable treated waste. The available data also would not lead us to conclude that the EP regulatory level for selenium cannot be achieved.

In the cases where the treated waste leachate did not achieve the EP regulatory level, the Agency looked at the waste characteristics and treatment design and operation to determine why the EP regulatory level was not attained. While we had limited waste characteristic data for these 3 points, we did not find any constituents in these wastes that were significantly different from other wastes achieving the EP regulatory level. We also showed wastes that had initial concentrations of the same order of magnitude achieving the EP regulatory level. Relative to analysis of the design and operation of the treatment systems used, the Agency had no data to determine whether poor design or operation contributed to the failure of the systems to achieve the EP regulatory level.

The Agency recognizes that we lack data on the full range of waste characteristics and design and operation conditions that may affect treatment effectiveness. Therefore, we are soliciting information to aid the Agency in analyzing treatment performance for cadmium wastes other than wastewater. The specific waste characteristics data and design and operating data that the Agency needs are described in Section V(E), Request for Comments.

TABLE 14.—SELENIUM DATA FOR WASTEWATER

Source [+]	Industry	Process generating waste	Treatment process	Waste codes	Waste characterization data		Selenium concentration data	
					Parameter	Concentration (mg/l)	Untreated total (mg/l)	Treated total (mg/l)
Battery Manufacturing Dev. Doc.	Lead battery manufacturing.	NAV	Lime and sodium hydroxide precipitation.	NAV	Nickel	5.84 mg/kg	30.2	<0.1
Battery Manufacturing Dev. Doc.	Lead battery manufacturing.	NAV	Lime and sodium hydroxide precipitation.	NAV	Nickel	6.86 mg/kg	28.6	<0.1
Battery Manufacturing Dev. Doc.	Lead battery manufacturing.	NAV	Lime and sodium hydroxide precipitation.	NAV	Nickel	5.63 mg/kg	27.4	<0.1

[+] See Section V(C)(10) for Data Source.
NAV—Not available.

TABLE 15.—SELENIUM DATA FOR WASTE OTHER THAN WASTEWATER

Source [*]	Industry	Process generating waste	Treatment process	Waste codes[a]	Waste characterization data		Selenium concentration data			
					Parameter	Concentration	Untreated		Treated	
							Total (mg/kg)	EP-Tox (mg/l)	Total (mg/kg)	EP-Tox (mg/l)
192[b]	NAP	Synthetic waste.	Stabilization	NAV	Barium	6,600 mg/kg	7,600	NAV	NAV	2.9
					Cadmium	10,300 mg/kg				
					Chromium	10,900 mg/kg				
					Lead	8,820 mg/kg				
					Mercury	11,300 mg/kg				
					Nickel	11,100 mg/kg				
					Silver	3,900 mg/kg				
					Arsenic	12,000 mg/kg				
192[b]	NAP	...do	...do	NAV	Barium	3,680 mg/kg	4,600	NAV	NAV	2.0
					Cadmium	5,500 mg/kg				
					Chromium	6,300 mg/kg				
					Lead	3,580 mg/kg				
					Mercury	600 mg/kg				
					Nickel	5,810 mg/kg				
					Silver	1,760 mg/kg				
					Arsenic	6,400 mg/kg				
617	EAF steel production.	Electric arc furnace.	...do	K061	Lead	38,000 ppm	1,000	NAV	NAV	0.02–0.04
					Cadmium	600 ppm				
					Chromium	1,100 ppm				
					Nickel	200 ppm				
					TOC	0.3–0.04%				
					Oil & grease	0.04–0.06%				

TABLE 15.—SELENIUM DATA FOR WASTE OTHER THAN WASTEWATER—Continued

Source [+]	Industry	Process generating waste	Treatment process	Waste codes[a]	Waste characterization data		Selenium concentration data			
					Parameter	Concentration	Untreated		Treated	
							Total (mg/kg)	EP-Tox (mg/l)	Total (mg/kg)	EP-Tox (mg/l)
192[b]	NAP	Synthetic waste.	do	NAV	Barium	18 mg/kg	750	NAV	NAV	1.5
					Cadmium	2,400 mg/kg				
					Chromium	1,710 mg/kg				
					Lead	1,170 mg/kg				
					Mercury	1,060 mg/kg				
					Nickel	1,360 mg/kg				
					Silver	290 mg/kg				
HAZCO[b]	NAV	do	do	NAV	Arsenic	1,100 mg/kg				
					Arsenic	2,267 mg/kg	599	NAV	580	<0.1
					Cadmium	1,090 mg/kg				
					Lead	1,872 mg/kg				
					Mercury	1,752 mg/kg				
					Waste lube oil	858,000 mg/kg				
					Alcohol	55,000 mg/kg				
CBI	CBI	CBI	do	NAV	Water	8,700 mg/kg				
CBI	CBI	CBI	do	NAV	CBI	CBI	80	NAV	NAV	0.28
681	EAF steel production.	Electric arc furnace.	do	K061	CBI	CBI	78	NAV	NAV	0.11
					Arsenic	50 mg/kg	70	NAV	10–40	<0.05
					Cadmium	200 mg/kg				
					Lead	15,000 mg/kg				
CBI	CBI	CBI	do	NAV	CBI	CBI	52	NAV	NAV	0.05
638	EAF steel production.	NAV	do	NAV	Chromium	1,120–1,140 ppm	0.13–51.8	NAV	NAV	0.006–0.021
					Nickel	291–314 ppm				
					Lead	156–334 ppm				
					Oil & grease	5.0%–18.4%				
CBI	CBI	CBI	do	NAV	CBI	CBI	48	NAV	NAV	0.41
CBI	CBI	CBI	do	NAV	CBI	CBI	35	NAV	NAV	0.01
CBI	CBI	CBI	do	NAV	CBI	CBI	30	NAV	NAV	0.08
CBI	CBI	CBI	do	NAV	CBI	CBI	26	NAV	NAV	0.08
CBI	CBI	CBI	do	NAV	CBI	CBI	26	NAV	NAV	0.20
CBI	CBI	CBI	do	NAV	CBI	CBI	25	NAV	NAV	0.14
CBI	CBI	CBI	do	NAV	CBI	CBI	24	NAV	NAV	0.14
CBI	CBI	CBI	do	NAV	CBI	CBI	23	NAV	NAV	0.15
CBI	CBI	CBI	do	NAV	CBI	CBI	21	NAV	NAV	0.12

[+] See Section V(C)(10) for Data Sources.
[a] Waste codes are reported in source.
[b] Data represent bench-scale data.
NAV—Not available.
NAP—Not applicable.
CBI—Confidential Business Information.

8. Thallium

The Agency does not have treatment data for thallium. We are considering a treatment standard for thallium of 0.9 mg/l as measured by the Extraction Procedure (EP) Toxicity Test (40 CFR 261).

a. *Wastewater.* In the absence of treatment data for thallium in wastewater, the Agency reviewed the theoretical solubility limits of thallium in comparison with the other California List metals. As shown in Table 16, the solubility product for thallium is much lower than for the other California metals. From these data, it appears that chemical precipitation can be used to achieve the EP regulatory level. The Agency solicits data and information that would aid in analyzing treatment performance for thallium in wastewater.

b. *Waste Other than Wastewater.* In the absence of treatment data for thallium in waste *other than wastewater,* the Agency reviewed the general literature on waste stabilization.

The literature review indicates that pH and solubility are significant factors affecting that solidification. In that pH is a controlled variable and the solubility of thallium is very low at high pH, it appears that it is theoretically possible to achieve the EP regulatory level. The Agency solicits data and information that would aid in analyzing treatment performance for thallium in waste other than wastewater.

TABLE 16.—SOLUBILITY PRODUCTS OF SELECTED METAL HYDROXIDES AND SULFIDES

Metal compound	Ksp
Lead: $Pb(OH)_2$	1.2×10^{-15}
Cadmium: $Cd(OH)_2$ fresh	2.5×10^{-14}
Nickel: $Ni(OH)_2$ fresh	2.0×10^{-15}
Thallium: $Tl(OH)_3$	6.3×10^{-46}
Mercury: $Hg(OH)_2$	$3.0 10^{-26}$
Arsenic:	
$As^{+3} + 3OH$	2.0×10^{-1}
As_2S_3	2.1×10^{-22}

Source: Lange's Handbook of Chemistry.

9. Cyanide

a. *Data Summary.* The Agency has 21 usable data points on the treatment of cyanide in wastewater from four facilities. Of the 21 data points, 20 are lower than the health based value of 20 mg/l. Eighteen of the data points that achieved the health-based prohibition level resulted from cyanide oxidation using ozone, one used alkaline chlorination, and one used electrolytic oxidation. The one data point that did not achieve the health-based prohibition level reflected electrolytic treatment. Table 17 provides a summary of all available data for cyanide in wastewater.

The Agency did not evaluate treatment of cyanide in wastes *other than wastewaters.* We believe treatment other than destruction is inappropriate; therefore, cyanide-containing wastes should not be solidified prior to treatment. We recognize, however, that

wastewater treatment will result in some concentration of cyanide in the residual solids. To exceed the health-based prohibition level of 20 mg/l, this residual concentration would need to be in excess of 400 mg/kg. The Agency does not believe this will be the case. The Agency, therefore, has not included data on treatment of cyanide-bearing sludges in this notice because no available data exist to show that these wastes contain cyanide concentrations that exceed 400 mg/kg.

b. *Data Analysis—Wastewater.* (i) Waste Characterization Analysis. As stated above, 20 of the 21 data points show that the health-based prohibition level for cyanide can be achieved. The Agency has limited data on the range of waste characteristics pertinent to an evaluation of the performance of cyanide oxidation technology. Most of the available waste characteristic data that are important to an engineering analysis involve other metals and total organic carbon.

The treatment data show a maximum influent concentration for cyanide of 75,000 mg/l. The literature indicates untreated wastes may have concentrations of cyanide as high as 100,000 mg/l, comparable to the highest cyanide influent concentrations for which the Agency has treatment data.

(ii) Design and Operating Parameter Analysis. The Agency has limited design and operating data from four facilities. Three of the facilities presented data for one point each and the fourth facility presented operating data for 18 points. The technologies used are ozonation, alkaline chlorination, and electrolytic oxidation.

(iii) Discussion. The Agency's best engineering judgment is that the health-based prohibition level of 20 mg/l for cyanide can be met for the full range of California List wastewaters containing cyanide. In support of this position, the Agency points to the cyanide oxidation theory and our knowledge of the technologies available to minimize the effects of constituents in the waste that can interfere with treatment performance. Additionally, the available data would not lead us to conclude otherwise.

In the case of the data point that does not show achievement of the health-based prohibition level of 20 mg/l, there are insufficient waste characterization data to indicate why the EP regulatory level could not be met. Additionally, for this data point, there is only limited design and operating data reported; however, it appears that insufficient retention time resulted in poor performance.

The Agency recognizes the lack of data on the full range of waste characteristics and design and operating conditions that may affect treatment effectiveness. Therefore, we are soliciting data on waste characteristics that can affect performance for cyanide in wastewaters. A description of the specific waste characterization data and design and operating data that the Agency needs can be found in Section V(E), Request for Comments.

TABLE 17.—CYANIDE DATA FOR WASTEWATER

Source [*]	Industry	Process generating waste	Treatment process	Waste codes [a]	Waste characterization data		Cyanide Concentration Data	
					Parameter	Concentration (mg/l)	Untreated total (mg/l)	Treated total (mg/l)
JWPCF	NAV	Plating bath wastes	Electroyltic oxidation	NAV	NAV	NAV	75,000	0.2
Chem Pro Inc.	NAV	Plating bath wastes and rinses.	...do...	NAV	TOC	37,000	16,000	1,000
Frontier Chemical Company.	NAV	Cyanide Drum Rinse	Cyanide oxidation by alkaline chlorination.	F007–	TOC	20,000	5,800–011,000	<5
				F012	Cadmium	230		
					Lead	21		
					Nickel	1,400		
Electro-plating Plant	NAV	Electroplating	Cyanide oxidation with ozone	NAV	NAV	NAV	130	0.90
Do	NAV	...do...	...do...	NAV	NAV	NAV	107	0.44
Do	NAV	...do...	...do...	NAV	NAV	NAV	83	0.86
Do	NAV	...do...	...do...	NAV	NAV	NAV	82	0.30
Do	NAV	...do...	...do...	NAV	NAV	NAV	76	0.90
Do	NAV	...do...	...do...	NAV	NAV	NAV	75	0.65
Do	NAV	...do...	...do...	NAV	NAV	NAV	72	0.54
Do	NAV	...do...	...do...	NAV	NAV	NAV	69	0.39
Do	NAV	...do...	...do...	NAV	NAV	NAV	68	0.41
Do	NAV	...do...	...do...	NAV	NAV	NAV	67	0.35
Do	NAV	...do...	...do...	NAV	NAV	NAV	66	0.38
Do	NAV	...do...	...do...	NAV	NAV	NAV	64	0.70
Do	NAV	...do...	...do...	NAV	NAV	NAV	58	0.30
Do	NAV	...do...	...do...	NAV	NAV	NAV	53	0.58
Do	NAV	...do...	...do...	NAV	NAV	NAV	49	0.10
Do	NAV	...do...	...do...	NAV	NAV	NAV	49	0.30
Do	NAV	...do...	...do...	NAV	NAV	NAV	48	0.50
Do	NAV	...do...	...do...	NAV	NAV	NAV	38	0.14

[*] See Section V(C)(10) for Data Sources.
[a] Waste codes as reported in source.
NAV-Not available.

10. Data Sources

Battery Manufacturing Dev. Doc.

U.S. Environmental Protection Agency. Development Document for Effluent Limitations Guidelines and Standards for Battery Manufacturing Point Source Category. Volumes I and II. EPA 440/1–84/067. August 1984.

Bhattacharyya, et. al.

Bhattacharyya, D., C. Sund-Hagelberg, K. Schwitzgebel, G.M. Blythe, and F.B. Craig. "Removal of Heavy Metals, Arsenic, and Fluoride from Smelter Effluents by Sulfide–Lime Precipitation." In: Proceedings of the Industrial Wastes Symposia. Las Vegas, NV. 1980.

CHEM PRO

U.S. Environmental Protection Agency, Office of Research and Development. Facility Test Report for

Chemical Processors, Inc., Seattle, Washington. Prepared by Metcalf & Eddy, Inc., under EPA Contract No. 68-03-3166. July 1986.

Electroplating Plant

U.S. Environmental Protection Agency, Office of Research and Development. Briefing—Technologies Applicable to Hazardous Waste. Prepared by Metcalf & Eddy, Inc.

Envirite

U.S. Environmental Protection Agency, Office of Solid Waste. Onsite Engineering Report of Treatment Technology Performance and Operation for Envirite Corporation. Prepared for EPA under EPA Contract No. 68-01-7053. December 1986.

EWE

U.S. Environmental Protection Agency, Office of Research and Development. Facility Test Report for Environmental Waste Enterprises, Eloy, Arizona. Prepared by Metcalf & Eddy, Inc., under EPA Contract No. 68-03-3166. February 1986.

Frontier Chemical Company

U.S. Environmental Protection Agency, Office of Research and Development. Facility Test Report for Frontier Chemical Waste Process, Inc. Prepared by Metcalf & Eddy, Inc., under EPA Contract No. 68-03-3166. November 1985.

HAZCO

Hazco. Technical Fact Sheet for HAZCO Solidification Agents.

JWPCF

Easton, John K. Electrolytic Decomposition of Concentrated Cyanide Plating Wastes. Water Pollution Control Federation Journal. 39:1621–1625. October 1967.

Lange's Handbook of Chemistry

Dean, John A. Lange's Handbook of Chemistry. Twelfth Edition. McGraw-Hill Book Company, 1979, pp. 5–12.

Metal Finishing Dev. Doc.

U.S. Environmental Protection Agency. Development Document for Effluent Limitations Guidelines and Standards for the Metal Finishing Point Source Category. EPA 440/1-83/091. June 1983.

Nonferrous Metals Dev. Doc.

U.S. Environmental Protection Agency. Development Document for Effluent Limitations Guidelines and Standards for the Nonferrous Metals Point Source Category, Volume III. EPA-440/1-83/019-6. March 1983.

UNH

Bishop, Paul L., Steven B. Ransom, and David L. Gress. "Fixation Mechanisms in Solidification/Stabilization of Inorganic Hazardous Wastes." In: Proceedings of the 38th Industrial Waste Conference, ed. John M. Bell. Boston: Butterworth Publishers, 1984, pp. 395–401.

126

Delisting Petition No. 126. Westinghouse Electric Corporation. Waste Code F006.

161

Delisting Petition No. 161. TRW Carr Division. Waste Code F006.

192

Delisting Petition No. 192. Chemlime Corporation. Waste Codes K062, D002, F006, F007, F008, F009, F012.

548

Delisting Petition 548. The General Motors Corporation, Fisher Body Division. Waste Code F006.

591

Delisting Petition No. 591. D.A.B. Industries, Inc. Waste Code F006.

617

Delisting Petition No. 617. Bethlehem Steel Corporation. Waste Code K061.

638

Delisting Petition No. 638. Chemical Waste Management. Waste Code Unspecified.

657

Delisting Petition No. 657. Universal Fasteners, Inc. Waste Codes F006, F008, and F009.

681

Delisting Petition No. 681. Bethlehem Steel Corporation. Waste Code K061.

688

Delisting Petition No. 688. Roanoke Electric Steel Corporation. Waste Code K061.

D. Conclusions.

The Agency has evaluated the technologies used to treat California List metals and cyanide wastes and its best engineering judgment is that wastewater and non-wastewater California List wastes can be treated to achieve EP regulatory levels or health-based prohibition levels for metals and to a level of 20 mg/l for cyanide. Given the potential diversity of California List wastes, the Agency does not believe it possible at this time to establish more tailored treatment standards, and so instead is evaluating treatment standards achievable by a wide group of wastes. More specific determinations will be made when rules establishing treatment standards for Section 3004(g) wastes are promulgated.

Table 18 summarizes the number of treatment data points that achieve the EP regulatory level for each constituent. The Agency does not have treatment data for thallium. For this constituent, we estimated that available treatment could achieve the health-based prohibition level based on a comparison of solubility products for the various California List metals and a review of the critical elements of effective stabilization technology.

TABLE 18.—NUMBER OF DATA POINTS MEETING THE EP VALUE

Constituent	Wastewater		Waste other than wastewater	
	No. of usable data points	No. meeting EP value	No. of usable data points	No. meeting EP value
Arsenic	3	3	11	11
Cadium	16	13	43	30
Hexavalent chr	7	7	7	2
Lead	16	15	94	90
Mercury	5	5	102	96
Nickel	35	34	40	38
Selenium	3	3	19	16
Thallium				

TABLE 18.—NUMBER OF DATA POINTS MEETING THE EP VALUE—Continued

Constituent	Wastewater		Waste other than wastewater	
	No. of usable data points	No. meeting EP value	No. of usable data points	No. meeting EP value
Cyanide	21	20		

It is EPA's tentative view that these data corroborate that the contemplated treatment standards can be achieved by a wide group of California List wastes.

The treatment data for all constituents are limited, however, particularly with respect to waste characterization data that affect treatment and design and operation of the technologies. The specific data that EPA is lacking for each California List metal and cyanide can be ascertained by combining the treatment technology discussion, which describes the data needed for an engineering analysis of technology performance (Section V(B)), with the data tables that present available data for each treated constituent (Section V(C)). In addition, within the Agency's data analysis discussions for each constituent, we have highlighted the data gaps and/or reported information concerning various aspects of waste characteristics, design, and operating parameters that might affect the Agency's preliminary conclusions that EP regulatory levels and health-based prohibition levels uniformly can be achieved.

EPA is soliciting comments on all aspects of the treatment data presented and is again requesting additional data that would impact on the Agency's preliminary assessment that treatment levels can be established at the EP regulatory levels or at health-based prohibition levels for the California List metals and at a level of 20 mg/1 for cyanide. In Section V(E), the Agency describes the specific data needed for its evaluation of additional data on treatment of California List metals and cyanide in wastewaters and wastes other than wastewater.

E. Request for Comments

Throughout this Notice of Data Availability, EPA has indicated that limited data exist to analyze treatment performance for wastes containing California List metals and cyanide. Existing data are only sufficient for corroborating engineering judgment. As noted earlier, the Agency lacks specific treatment data (i.e. waste characterization, design, and operating data) for certain categories of California List metals and cyanides. This section describes the specific waste characterization and design and operating information that should accompany any waste treatment data supplied to the Agency. In this section, we have only provided specific data requests for the technologies associated with the vast majority of the data. For other technologies upon which commenters wish to provide treatment data, the commenter should refer to Section V(B), Applicable Technologies, for a listing of the data needed by the Agency.

1. Wastewaters Containing California List Metals, Except Hexavalent Chromium

For Wastewaters, the principal technology used to treat California List metals (excluding hexavalent chromium) is chemical precipitation.

a. *Waste characterization data.* The specific waste characterization data needed to assess the performance of this technology include:

• Initial metal concentration of untreated wastewater;
• Whether the metal exists as a complex;
• Valence state for the metals, arsenic, chromium, lead, and mercury;
• Other metals present in the waste;
• Presence of high concentrations of dissolved inorganic solids in solution (i.e., salinity);
• Presence of oil and grease in the waste; and
• Presence of surfactants in the waste.

b. *Design data.* The Agency needs design data on the treatment system used to treat the wastes. If a continuous chemical precipitation system was used, EPA needs the following design data:

• Design pH value and the basis for selection of this value (e.g., bench scale jar test results). The commenter should also provide the temperature at which the design tests were performed.
• Design treatment chemical(s) used to achieve the pH value.
• Design settling time, associated untreated waste feed rate and tank size, and the basis for selection of these values (e.g., total suspended solids (TSS) value from bench scale jar tests). Include information on any flocculating or coagulating aids used to improve settling characteristics and reduce required retention times.

For batch treatment systems, the Agency needs the same design information listed above, except it does not request waste feed rate and tank size.

c. *Operating data.* The operating data that the Agency needs to ensure that the design conditions were being achieved during generation of the treatment data are:

• pH and temperature values throughout the treatment period; and
• Untreated wastewater flowrates throughout the treatment period.

For batch systems, the Agency needs the same information except, instead of wastewater flowrate, we need the settling time and/or any operating parameter used as a check to ensure that sufficient settling has been accomplished (e.g., TSS, turbidity, or metal concentration in the treated waste).

2. Wastewaters Containing Hexavalent Chromium

For wastewaters containing hexavalent chromium, the principal treatment technology is chromium reduction.

a. *Waste characterization data.* The specific waste characterization data needed to assess the performance of chromium reduction technology include:

• Initial hexavalent chromium concentration in the untreated wastewater;
• Whether the hexavalent chromium exists as a complex;
• Other metals that could be reduced; and
• Presence of oil and grease in the waste.

b. *Design data.* The Agency needs design data on the treatment system used to treat hexavalent chromium. If a continuous hexavalent chromium reduction system was used, EPA needs the following design data:

• Design ORP (oxidation—reduction potential) value and the basis for selection of this value (e.g., bench scale tests comparing ORP readings with hexavalent chromium concentrations).

The commenter should also provide the associated pH values.

- Design treatment chemical(s).
- Design retention time, associated untreated waste flow rate and tank size, and the basis for selections of these values (e.g., ORP value from bench scale tests).

For batch treatment system, EPA needs the same design data, except it does not request waste feed rate and tank size.

c. *Operating data.* The operating data that the Agency needs to ensure that the design conditions were being achieved during generation of the treatment data are:

- ORP and pH during the treatment period; and
- Untreated wastewater flow rate during the period of treatment.

For batch hexavalent chromium reduction systems, EPA needs the same data except instead of wastewater flowrate, the Agency needs the retention time of the waste during treatment or the operating parameter used to determine that reduction was complete (e.g., hexavalent chromium concentration or ORP).

3. Wastewaters Containing California List Cyanides

For wastewaters containing "free" cyanide, the principal treatment technology is cyanide oxidation.

a. *Waste characterization data.* The specific waste characterization data needed to assess the performance of this technology include:

- Initial concentration of cyanide in the wastewater;
- Presence of metals that complex with cyanide (e.g., iron and nickel);
- Presence of metals that can be oxidized (e.g., trivalent chromium and ferrous iron);
- High levels of oil and grease; and
- High levels of surfactants.

b. *Design data.* The Agency needs design data on cyanide oxidation systems used to treat "free" cyanide wastewaters. If a continuous oxidation system was used, EPA needs the following design data:

- ORP design value and the basis for selection of this value (e.g., bench scale tests comparing ORP readings with "free" cyanide concentration). The commenter should provide the associated pH values;
- Type of oxidizing agent and the basis for selection; and
- Design reaction time, associated flow rate of the waste, and the basis for selection of these values (e.g., cyanide levels in bench scale tests).

For batch treatment systems, the Agency needs the same design

information except it is not requesting waste feed rate.

c. *Operating data.* The operating data that the Agency needs to ensure that the design conditions were being achieved during generation of the treatment data are:

- ORP and pH values throughout the treatment period; and
- Untreated wastewater flowrate throughout the treatment period.

For batch systems, the Agency needs the retention time or any operating parameter (e.g., cyanide concentration or ORP) used as a check to ensure sufficient oxidation has been accomplished.

4. Wastes Other Than Wastewater Containing California List Metals

For wastes other than wastewater, stabilization was the treatment technology used in all instances.

a. *Waste characterization data.* The specific untreated waste characterization data that EPA needs are:

- Initial metal concentrations for the untreated waste;
- Initial metal concentrations in the untreated waste leachate;
- Other metals present;
- Presence of certain dissolved inorganic and organic compounds containing metal salts, sulfates and borates that can affect stabilization; and
- Presence of high levels of oil and grease.

b. *Design data.* The Agency also needs the following design data for the stabilization system used to treat the waste:

- Specific stabilizing agent and other additives used and the ratio of waste to stabilizing agent, and the basis for this selection (e.g., bench scale test data). The commenter should also provide the temperature and humidity at which any bench scale or other design-basis tests were performed.
- Design curing time and the basis for selection of this value (e.g., unconformed compressive strength tests of stabilized waste matrix).

c. *Operating data.* The operating data that EPA needs to ensure that design conditions were being achieved during generation of the treatment data are:

- The ratio of waste to stabilizing agent;
- The curing time for the stabilized waste including the basis for determining that the waste was completely stabilized (e.g., compressive strength tests); and
- Ambient temperature and humidity during the curing process.

VI. Alternative Treatment Capacity For California List Metals and Cyanides

A. Volumes Requiring Alternative Capacity

For promulgation of the California list final rule (52 FR 25760, July 8, 1987), EPA estimated that the maximum volumes of metal and cyanide wastes that would require alternative treatment capacity would be 8,440 million gallons of metal wastes per year, and 690 million gallons of cyanide wastes per year (see Background Document for California list wastes—final rule). (These volumes, however, do not include hazardous wastes being injected pursuant to the Underground Injection Control Program.) These volumes represent the maximum possible volume of California list wastes, rather than the volume of wastes which exceed the statutory prohibition levels. The volume estimates are based on the 1981 RIA Mail Survey, which contained very little quantitative concentration data. Therefore, these volumes include all hazardous waste streams that were land disposed and that contained any cyanides or California list metals. The Agency also estimated that of these wastes, 25 million gallons could be cyanide-bearing sludges, and over 1,455 million gallons could be metal-bearing sludges. The Agency expects that these wastes would be treated by solidification or other non-wastewater treatment technologies, while the remaining wastewaters would be treated by wastewater treatment technologies.

EPA recognizes the limitations of the data bases for estimating volumes affected by the California list rule, and thus requests data indicating the volumes of wastes that would be affected if EPA lowers the restriction levels. EPA requests that commenters differentiate among specific metal-bearing (i.e., arsenic, cadmium, chromium, lead, mercury, nickel, selenium, or thallium) and cyanide-containing wastes that currently are land disposed. In addition, the commenters should indicate whether the waste is a wastewater, or a sludge or solid that either is a liquid (as defined by the PFLT) or is derived from treating a liquid waste that contains greater than the prohibition levels (i.e., the EP regulatory levels or analogous health-based levels) of California list constituents discussed in this notice. Commenters should also indicate management methods currently used for these wastes, and address whether the wastes meet the treatment standards under consideration in this notice.

B. Alternative Treatment Capacity

EPA currently has limited information on available alternative treatment for metals and cyanides. Analysis of the 1981 RIA Mail Survey indicated a limited amount of commercial capacity. However, comments on the proposed California list rule indicate that there have been significant changes in commercial capacity since the 1981 survey. Thus, EPA is requesting information on the volume of available commercial capacity for treatment of *metals and cyanides* capable of achieving the prohibition levels discussed in this notice. In addition, some commenters have indicated that additional on-site capacity exists that could be used to manage California list wastes that were also generated on-site. Certain facilities may already have on-site treatment systems or may have impoundments satisfying the § 268.4 and RCRA section 3005(j)(11) criteria to handle these California list wastes. In addition, some *facilities* may be able to *expand or upgrade* their existing treatment capacity quickly to handle their California list wastes. Thus, EPA is requesting information with respect to on-site treatment capacity, particularly capacity built after 1980. In addition, EPA is also requesting information on the time needed to develop new capacity, especially the time needed to develop large treatment systems. Commenters should address all steps in development of capacity: general planning, engineering design and plans, bid solicitation and evaluation, construction and start-up.

C. Possible National Capacity Variances

The greatest volumes of potential California list wastes shown in the 1981 survey are wastewaters managed in surface impoundments. 51 FR 44732. These wastes could require alternative treatment capacity in non-land based units (presumably tanks) or in retrofitted surface impoundments satisfying § 268.4. Commenters to the proposed California list rule have stressed the difficulties in installing alternative treatment systems without substantial delay. EPA has noted that these comments have merit in many cases. If the volumes of metal-bearing and cyanide-containing wastes needing alternative treatment exceed available capacity, the Agency would consider granting national capacity variances.

EPA believes the maximum duration of such a variance would be November 8, 1988, the date on which most interim status surface impoundments must meet minimum technology requirements, or cease receiving, storing or treating hazardous wastes (RCRA section 3005(j)(1)). If affected facilities do not retrofit their surface impoundments to comply with these requirements, these facilities must develop alternative treatment systems on-site (e.g., tank treatment), or transport the wastes off-site for treatment. The Agency expects that facilities which generate certain large volume flows will either retrofit surface impoundments to meet the 3005(j)(1) requirements, or install tank treatment systems as necessary. New capacity developed to comply with the minimum technology requirements, along with existing commercial capacity, should provide sufficient capacity for California list metals and cyanides beyond November 8, 1988. The Agency solicits comments on this tentative conclusion.

VII. Alternative Procedures for Treatability Variances

The Agency noticed for comment in the December 11, 1986 proposed rule the issue of using non-rulemaking procedures for processing treatability variances (§ 268.44). 51 FR 44729. In the recent final rulemaking on California list hazardous wastes (52 FR 25760), the Agency determined that treatment method equivalency petitions (§ 268.42(b)) need not be processed by rulemaking where the relief sought would not have generic applicability and effect. 52 FR 25780. The Agency believes tentatively that this same reasoning could apply to the analogous treatability variance and therefore solicits further comment on the issue of amending § 268.44 so that informal rulemaking procedures are not mandated for all applications.

Dated: July 24, 1987.

J. Winston Porter,
Assistant Administrator.
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